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1929.

LIVERWORTS OF THE WESTERN HIMALAYAS AND THE PANJAB PLAIN

(ILLUSTRATED)

PART I

BY

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PREFACE.

The only comprehensive work on Indian Liverworts was published by Mitten in 1860 (Jour. Linn. Soc. Vol. V. No. 18,19). His paper, however, gives only the names of the species already known, and descriptions are given only in the case of new species. Since then many more species have been described, specially by Stephani in his "Species Hepaticarum," the last volume of which was published in 1925. The descriptions in both these works are in Latin, and whereas the former work is very old and out of date, the latter, dealing as it does with the liverworts of the whole world, is too large and costly and, therefore, beyond the reach of the ordinary student. Both these works are without illustrations. It is highly desirable that a handy volume should be available on the Indian species of this fascinating group. For many years the writer has been observing and collecting these plants in the Himalayas and has described a number of new species. The present work has been undertaken to bring together the descrptions of all the species which have been seen by the writer in the Himalayas West of Nepal and the Panjab Plain, and to these has been added a number of species not seen by the writer but given by Stephani in "Species Hepaticarum" as occurring within this area. This work, therefore, should form the groundwork for a more intensive study of these plants. Many excellent works dealing with the local Liverwort Flora of European countries are available in English and other European languages, and it is the hope of the writer that the present little volume may lead to an increased interest in the plants of this group occurring in India when more detailed works would no doubt be forthcoming.

The present volume deals with the *Anthocerotales*, *Marchantiales*, *Sphaerocarpales*, and the *Anacrogynous Jungermanniales.* The second volume would deal with the *Acrogynous Jungermanniales.* It may be possible by and by to produce a work dealing with the Liverworts of the whole of India, but this requires large collections from the Eastern Himalayas and South India which are particularly rich in foliose forms.

In the case of indigenous species fuller descriptions and more figures are given than in the case of others which have a wider distribution and have been fully described and figured in many books.

PANJAB UNIVERSITY,
LAHORE,
June 1929.

S. R. KASHYAP.

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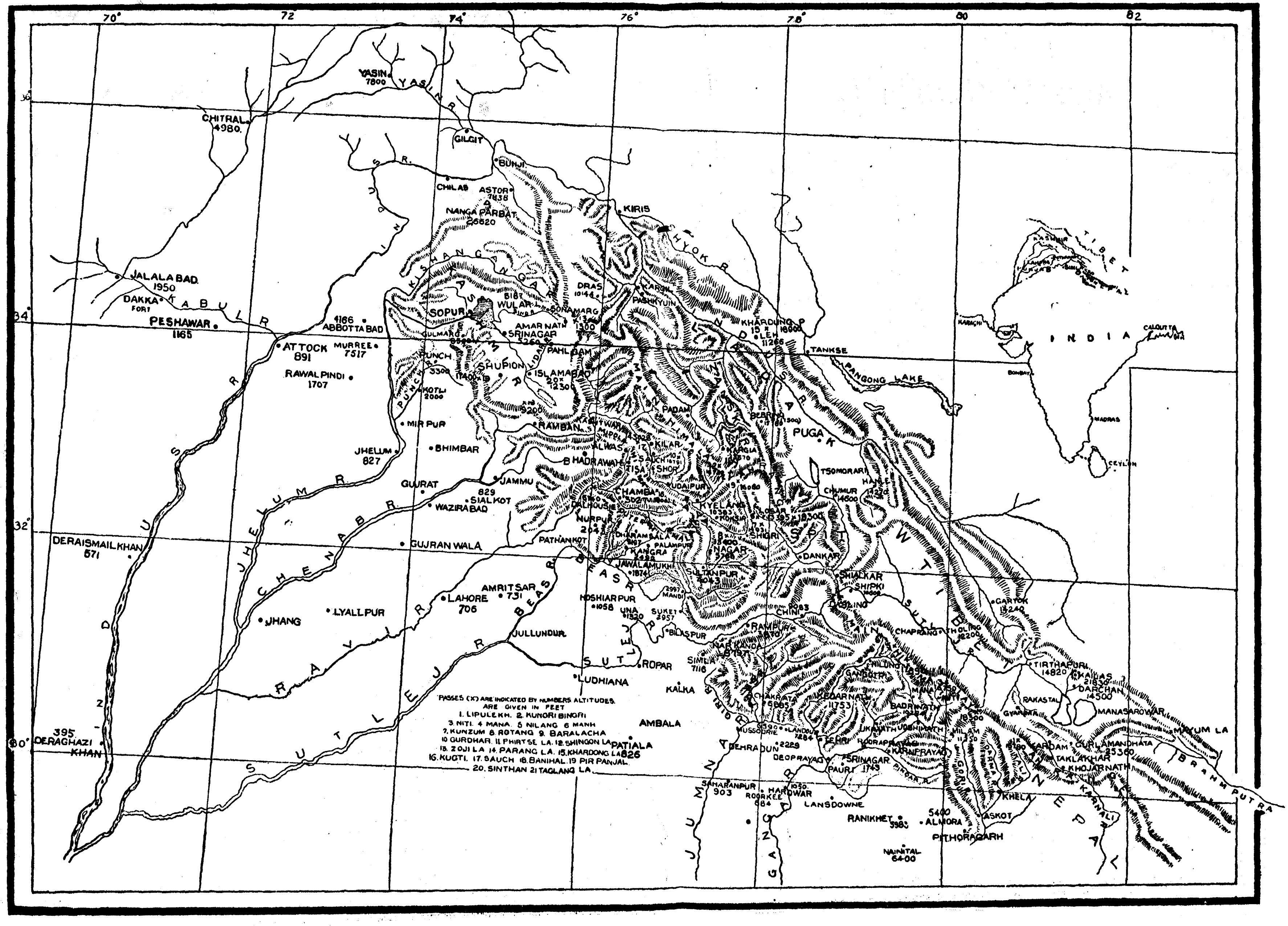
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7. KUNZUM 8. ROTANG 9. BARALACHA
10 GURDHAR. 11 PHIRTSE LA. 12. SHINGON LA
13. ZOJI LA 14. PARANG LA. 15. KHARDONG LA
16. KUGTI. 17. SAUCH 18. BANIHAL. 19 PIR PANJAL.
20. SINTHAN 21 TAGLANG LA.

INTRODUCTION

GENERAL CHARACTERS.

Liverworts form one of the two classes into which it is customary to divide the group Bryophyta, the other class being the Mosses. The liverworts are either thallose, without any differentiation into stem and leaves, or leafy. In the case of the thallose forms there is no difficulty in distinguishing them from the mosses. They are prostrate, dorsiventral, usually forked, fixed to the soil by means of rhizoids, and in many cases, possess scales on the ventral surface. The leafy forms superficially resemble the mosses, but can be distinguished from them more or less readily by means of several characters. The leafy liverworts are generally more or less prostrate and have as a rule two rows of leaves, though, in some, a third ventral row is present; but in mosses the leaves are usually spirally arranged in several rows. The leaves of liverworts are practically always without a midrib which is generally present more or less distinctly in moss leaves. The rhizoids of the liverworts (by which they are fixed to the substratum : soil, bark of trees, etc.) are unseptate, unlike those of the mosses which are transversely septate. The protonema in liverworts is small, ephemeral ; in mosses it is very much developed, filamentous and branched. The capsule in liverworts contains, in most cases, besides the spores, sterile cells —elaters, which are absent from the moss capsule. The columella and the peristome, which are charecteristic of most mosses, are absent in the liverworts except in the *Anthocerotaceae* where a columella is usually present.

ALTERNATION OF GENERATIONS.

The liverworts, like the mosses, exhibit a distinct *alternation of generations*. The ordinary plant is the sexual stage, *gametophyte*, and bears the sex organs, *antheridia* or the male organs containing sperms, and *archegonia* or the female organs containing the egg. The antheridia and the archegonia may occur on the same plant, when the plants are called *monoecious*, or they may be found on different plants, *dioecious*. After fertilisation by the sperm the egg develops into the asexual stage or the *sporophyte*, called in Bryophyta by the special name *sporogonium.* In the higher forms the sporogonium consists of three parts, *i.e.*, the *foot*, the *seta*, and the *capsule.* The foot serves to fix the sporogonium in the tissue of the gametophyte, seta serves to bring the capsule out, and the capsule is a sort of vessel for containing *spores* and *elaters.* The wall of the capsule is made of one or more layers of cells. The capsule dehisces variously, setting the spores free. The spores on germination again produce the gametophyte. In simpler forms the seta is very rudimentary, merely a constriction, and in some very simple forms both foot and seta are absent.

VEGETATIVE REPRODUCTION.

In addition to the usual mode of reproduction described above, these plants propagate themselves vegetatively also, when the conditions are favourable for vegetative growth. The commonest method is by the death of the older parts separating the younger branches, which grow into new plants. Many species propagate by means of *gemmae* which are found in receptacles of various shapes, on the tips of branches or on the margins of leaves. They are generally green and are meant for increase in number of plants during the favourable season. They germinate immediately, and if dried, die. Some plants form more or less definite tubers, by the modification of shoots or parts of shoots, to tide over the period which is unfavourable for growth. These tubers are usually buried under ground and are not much affected by changes of temperature or drought.

AREA DEALT WITH.

The area dealt with in this book consists of (1) the Himalayas from the border of Nepal in the east to Kashmir in the west: *i.e.*, the Kumaon Himalayas, including the districts of Almora and Garhwal; the Panjab Himalayas, including the valleys of the Sutlej, the Beas, the Ravi, the Chenab (Chandra-Bhaga) with its two branches, the Chandra and the Bhaga; the Kashmir Valley; Ladak; the isolated valleys of Spiti and Zanskar; (2) the Panjab plain and some portions of the North-West Frontier Province. Collections have been made in all these localities by the writer personally, and the plants were seen in the living condition. Specimens received from other sources are indicated in their proper places. Western Tibet proper from Kunawar to the source of the Sutlej has also been visited on several occasions but it may be stated at once that no liverworts have been found in that region. Strictly speaking, the districts of Garhwal and Almora should not be included in the "Western Himalayas" but as the country is in continuation of the Western Himalayas and they have been visited many times, they are included in this area. Both districts are very rich in liverworts. A few species have been included which have not so far been met with in the area but may be expected to occur.

Under distribution references are given to other parts of India also when specimens have been seen by or sent to the writer from such places.

CLIMATE.

(1) THE PLAINS.

Liverworts require a good deal of moisture during the growing season. The Panjab plains are very hot and dry during the summer which is, therefore, very unfavourable for their growth. The winter is a little less unfavourable. Some thallose forms are met with here and there near water and spore-formation is complete before the onset of the severe summer heat. The few liverworts met with in the plains right up to the foot of the hills are practically all thallose.

(2) THE MOUNTAINS.

The mountains are very much more favourable for the growth of liverworts. The winter, however, is the resting season there on account of low temperature and scanty precipitation. The growth is active during summer and the rainy season—May to September. The plants are in their full bloom in the rainy season—July and August, ripening their fruits from August to September. The number of species and individuals is directly proportional to the amount of moisture, especially the rainfall.

As is well known, in the western part between the Sutlej and Kashmir, the Himalayas form three more or less parallel ranges running south-east to north-west. The outermost is the *Outer Himalayas* on which most of the summer resorts of the Panjab are situated. The *Middle Himalayan* range is separated from the outer by the Ravi (Chamba) valley, and is higher than the outer range. The *Inner* or the *Main* range is the highest and is separated from the middle by the valley of the Chandrabhaga (Kishtwar, Padar, Pangi, and Lahul). Beyond this range lies the Trans-Himalayan region (Ladak). The rainfall is heaviest in the outer Himalayas and the liverworts are most numerous in this region. The greatest development is reached at an altitude of 5,000 feet to 8,000 feet above the sea level. In the Ravi valley the rainfall is smaller, and in the Chandrabhaga valley it is smaller still, and the number of species and individuals falls proportionately. Beyond the main Himalayas the rainfall is exceedingly low and the number of liverworts is reduced to a very few species. In Western Tibet as already stated there are no liverworts. Their number, again, decreases as we travel from the south-east to the north-west along the whole mountainous area. At higher altitude cold becomes another inhibiting factor, in addition to the decreased moisture. The highest altitude is reached by *Preissia quadrata, Marchantia polymorpha* and *Sauchia spongiosa,* just beyond the Bara Lacha Pass at about 15,000 feet, the last species occuring at a slightly lower level than the other two species.

The details of rainfall and temperature of some stations in the plains and hills, together with the species occurring in the plains and certain valleys are given in the appendices.

PERENNATION IN THE HILLS.

A few species like *Anthoceros erectus* and *Notothylas Levieri* seem to be annual, but the rest are perennial. Some, as the species of *Dumortiera*, *Pellia* and *Marchantia*, grow under water or very near water, remaining alive and fresh throughout the year, but even in these cases growth is not very active in winter. Others simply dry up in winter, and resume their growth at the beginning of the rainy season. These include all the foliose forms and some thallose forms, such as the species of *Plagiochasma*, *Reboulia*, *Grimaldia*, *Fimbriaria*, etc., which on getting dry roll their margins upwards, protecting the upper green surface and exposing the lower purple surface covered with scales. On being moistened they become flat again and begin to grow. Still others have their apical portion more or less thickened and, in some, modified in other ways also, and this is the only portion which persists in winter, the older portion dying away, *e. g.*, species of *Cyathodium*, *Cryptomitrium* and *Athalamia.* In some there are very definite rounded or cylindrical tubers with or without stalks which remain buried under ground during winter, such as species of *Exormotheca Stephensoniella*, *Fossombronia*, *Sewardiella*, and *Anthoceros himalayensis*.

HABITAT.

The thallose forms, excepting the few that occur in very moist places or actually under water, are usually met with on exposed slopes. whereas the foliose forms are restricted to very shady and moist places on rocks or more often as epiphytes. Ecologically, therefore, the *Marchantiales* and the *Anacrogynous Jungermanniales* together with the *Anthocerotales* form one group, and the *Acrogynous Jungermanniales* another.

Plants of the same species *usually* vary in size according to the amount of moisture available. Specimens growing in moist places are larger than those in dry places. Similarly, speaking *generally* of the Marchantiales, species growing under water or on moist places are larger than those growing in dry places. *Dumortiera* growing actually under water possesses the largest thallus. *Conocephalum* occurring in moist places is not much smaller. *Wiesnerella* is fairly large. Passing through the many other species of medium size we reach the genus *Riccia* in which the thallus is usually very small and some of the species are among the smallest liverworts in this group.

ARRANGEMENT OF GENERA.

A few words are needed regarding the arrangement of families and genera. The arrangement adopted in this book is from the highest to the lowest, which is contrary to what is usually followed in most of the books. In the writer's opinion the evidence for the derivation of simpler forms from the more complex ones is very strong. It is of course impossible to arrange all the genera along one line of descent. It is clear that there have been not only several lines of descent but also branches from these main lines, so that the arrangement along one line of descent becomes impossible. The reduction, moreover, does not affect all the organs uniformly. One part may be affected more than another. It is possible that, in some cases, one part is being simplified, whereas another is being more highly differentiated. The relationships of the genera have been indicated, wherever necessary, in the body of the book. This subject is dealt with more fully in my Presidential Address to the Botany Section of the Indian Science Congress at Bombay, 1919 (Proceedings of the Asiatic Society of Bengal, New Series, Vol. XV, No. 4, 1919).

In the *Anthocerotales* it is probable that the simple genus *Notothylas* has been derived by reduction from a higher form, as is shown by the presence of very definite and well-developed lines of dehiscence although the capsule never comes out of the involucre and has no chance of opening. It appears that the ancestral form in this group was erect and radial as is still the case in some specimens of *A. erectus* while the more common prostrate form is derived from it through intermediate stages.

In the *Marchantiales*, however, several lines of descent are traceable. One line is especially clear and includes a large number of genera. This is from the level of *Marchantia* downwards through *Conocephalum*, *Exormotheca*, *and Aitchisoniella* to *Targionia*. From *Exormotheca* a branch line is given off towards *Stephensoniella*, *Boschia* and *Corsinia*. Along this line the number of involucres in the receptacles is gradually reduced, though the number of archegonia in each involucre remains fairly large. The receptacle remains terminal but the stalk is gradually reduced till we find that in *Targionia* the lobe of the receptacle grows out into a vegetative lobe bearing the involucre at the apex. The stalk in the branch-line (*Stephensoniella* line) becomes gradually shifted to the dorsal side, becomes small, and is ultimately lost in *Boschia* and *Corsinia*. At the same time the capsule wall and the elaters undergo simplification as regards the fibrous bands found on them. In both cases the ultimate result has been the loss of the stalk, in one case without shifting of the position of the receptacle from the apex to the dorsal side and in the other cases along with this change in the position of the receptacle. For this reason the family *Targioniaceae* has been merged into the family *Marchantiaceae*. Another line is from *Conocephalum* to *Dumortiera* through *Wiesnerella*.

The *Astroporae*, *Operculatae* and *Compositae* of Leitgeb can be maintained for the sake of convenience of study only, otherwise there is no hard and fast line between them as shown by forms like *Aitchisoniella*, *Athalamia pusilla* and *Sauchia spongiosa.*

In the *Astroporae* the number of involucres in the receptacle remains fairly large but the number of archegonia in each involucre is reduced to one ultimately, and the capsule retains the fibrous band on its wall-cells. The thallus, however, has in most cases developed the typical star-like pores with thick radial walls and narrow chambers.

In the *Operculatae* the capsule wall has lost the fibrous bands, the pores are thin-walled, but in the number of involucres and archegonia the group resembles the *Astroporae.* In both these groups the terminal stalk has ultimately been shifted to the dorsal side, as is seen in *Plagiochasma* and *Athalamia.* In *Plagiochasma* particularly this process is seen very clearly.

The occurrence of fixed elater-like cells at the base or apex or both places in the capsule of the higher *Marchantiales* probably indicates that it is a remnant of the columella which must have been present in the ancestral form. A nearer approach to the columella is found in some of the *Anacrogynous Jungermanniales*, as *Pellia* and *Aneura.* In the *Anthocerotales* a columella is of course generally present.

In the *Jungermanniales* these lines are not so fully worked out, but it seems probable that the foliose forms have given rise to the thallose forms by condensation, and at the same time the terminal cluster of archegonia has become shifted to the dorsal side as the erect habit gradually passed into a prostrate one. *Fossombronia* and *Sewardiella* are good examples of this process of derivation by condensation of one form from the other. It is well known that in some *Acrogynous Jungermanniales (Pteropsiella*, *Metzgeriopsis* and *Protocephalozia)* the vegetative body is thallose but leaves appear in connection with the sex organs on fertile shoots. It is reasonable to suppose that the bracts in connection with the antheridia and archegonia in the thallose *Anacrogynae* are homologous with the leaves of the *Acrogynae* and vestiges of the leafy habit of the ancestral forms which has been lost in the vegetative portion. The bell-shaped perianth in forms like *Sewardiella* arises as a group of separate scales which are carried upwards later on by basal growth more or less in a circle. Here again the individual developmeut indicates the presence of leaf-like structures at an earlier period. In the case of the antheridia these scales usually remain free.

The main factor in this reduction in the whole class has obviously been an increase of vegetative growth at the expense of sexual reproduction (and therefore simplification of the structure of the sexual receptacles), probably as an adaptation to a drier habitat, at least in most cases. The probable origin of the genus *Riccia* is indicated under that genus in the body of the book.

VARIABILITY

Many of the liverworts are very variable. Details will be given at the proper places in connection with the different species. Disregard of this fact is apt to lead to multiplication of species, when as a matter of fact, we may be dealing only with modifications due to habitat. Field observations on living plants growing under various conditions are necessary to realize the great range of variability. It is very difficult to judge from scanty herbarium material whether a form is a species or merely a variety. Some of the species described in this book have a very wide range of distribution under very different climatic conditions and a few occur at altitudes varying from less than 1,000 feet to 10,000 feet, 12,000 feet, and even 14,000 feet above the sea level. Such plants afford a particularly favourable material for the study of variation in relation to the different climatic factors. It is not only the vegetative parts of the plant which vary in form and size but, in some cases, even such fundamental structures as the spores and the sexual receptacles differ a good deal in various ways in different individuals of the same species.

MYCORRHIZA.

Fungal hyphae are quite commonly met with in the cells of the midrib in the older parts of many thallose forms. In most cases the fact is mentioned at the proper place under the various species. The hyphae penetrate into the thallus through the rhizoids (in the case of the Marchantiales through the smooth rhizoids). As the fungus often occurs in the older parts of the thallus it appears that the union is not always symbiotic but the fungus is at least in many cases merely a parasite on the Liverwort.

SYNONYMS.

It will be seen that very few synonyms are cited, and these only where they were thought to be absotutely necessary. Synonyms are available to the specialist in larger works.

CONSPECTUS

ORDER I.

ANTHOCEROTALES.

Gametophyte a thallus, without air-chambers and scales, but possessing slit-like pores on the under-surface. Each cell with a large chloroplast. Rhizoids smooth. (Antheridia in clusters, in closed cavities near the dorsal side. Archegonia embedded in the tissue of the thallus on the dorsal side. Sporogonium with a bulbous foot, a growing region, and a long capsule dehiscing from the apex downwards by two valves. Columella well-developed, of 16 rows of cells (except in *Notothylas* where the columella is often absent), arched over by the archesporium. Capsule wall usually green, and stomatiferous. Sterile cells simple or branched, mixed with the spores. *Nostoc* colonies are found embedded in the thallus.)

FAMILY I. ANTHOCEROTACEAE.

Characters same as those of the Order.

ORDER II.

MARCHANTIALES.

Gametophyte a thallus, and with the single exception of *Dumortiera* with air-chambers in the dorsal layer opening usually to the outside by means of pores. Scales on the under surface, usually in rows. Rhizoids usually of two kinds, smooth and tuberculate. Sex organs scattered on the dorsal surface in the simplest forms, arranged in receptacles in the higher forms, receptacles stalked in the highest forms. Capsule without a foot, seta, and elaters in the simplest forms, but with all these in the higher forms.

FAMILY II. MARCHANTIACEAE.

Dorsal layer with well-developed air-chambers with or without assimilating filaments (exception *Dumortiera*). Pores well defined. Sex organs in groups, often on long-stalked receptacles. Sporogonium with foot and seta. Elaters present. Dehiscence by a more or less definite lid or valves.

FAMILY III. RICCIACEAE.

Dorsal layer with narrow air spaces or wide chambers; definite pores absent or rudimentary. Antheridia and archegonia usually scattered on the dorsal side and embedded in the dorsal tissue of the thallus. Sporogonium without foot and seta. Elaters absent. Spores come out by the decay of the capsule-wall and the thallus.

ORDER III.

JUNGERMANNIALES.

Gametophyte a thallus or differentiated into stem and leaves, with little histological differentiation. Scales usually absent. Rhizoids always smooth. Archegonia usually arranged in groups but never raised on stalked receptacles, antheridia occasionally immersed in cavities. Sporogonium with foot and seta. Capsule wall two or more cells in thickness. Elaters present. Dehiscence usually by 4 valves.

SUBORDER **Anacrogynae**.

Gametophyte generally a thallus, sometimes with stem and leaves. Sex organs on the dorsal side. Archegonia in groups.

FAMILY IV. CODONIACEAE.

Thallose, foliose, or forms intermediate between them. In the foliose forms the leaves are in two rows, parallel to the stem or obliquely inserted and succubous, simple. Archegonial group surrounded by a perianth, and in the genus *Calycularia*, by an additional involucre also. Capsule usually with a long seta, globose or oval, dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells, well-developed fibrous bands being usually present on either the outer or the inner cells, or on both. Elaters adherent to the base of the capsule or partly free, more rarely altogether free, 2-4 spiral.

FAMILY V. ANEURACEAE.

Thallus fleshy or membranous, in *Metzgeria* with a sharply-defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, composed usually of two layers of cells of which the inner possesses more or less distinct semi-annular bands. Elaters either tapering towards each end, with one broad spiral band; or fixed, short and obtuse, with an indistinct spiral band, and persistent as erect tufts at the apex of the valves.

SUBORDER **Acrogynae.**

Gametophyte with stem and two rows of lateral, and frequently a third ventral row, of leaves. Archegonia in a terminal cluster. (To be taken up in the second volume).

ORDER IV.

SPHAEROCARPALES.

Gametophyte a thallus, without air-chambers and pores. Rhizoids smooth. Each antheridium and archegonium enclosed in a special envelope. Sporogonium with a large foot and a short seta. Capsule wall one-layered without fibrous bands on the cells. Sterile cells thin-walled and disappearing at maturity. Dehiscence irregular.

FAMILY VI. RIELLACEAE.

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters the same as those of the Order.

KEY TO THE GENERA.

1 Plants without air-chambers and pores, usually without scales on the ventral surface 2
Plants with air-chambers and pores (except *Dumortiera*), usually with scales on the ventral surface 12

2 Capsule linear, thallus with *Nostoc* colonies 3
Capsule more or less globose, thallus without *Nostoc* colonies except in *Blasia* 4

3 Capsule long, linear, dorsal, coming out of the involucre .... *Anthoceros*
Capsule short, marginal, included .... *Notothylas*

4 Plants growing under water, with a dorsal wing, each sex organ in an inflated envelope .... *Riella*
Plants terrestrial, with lateral wings, individual sex organs without any envelopes 5

5 Plants with leaf-like lateral lobes, ... 6
Plants with a midrib and lateral wing not divided into lobes.. 7

6 Plants without *Nostoc* colonies, rhizoids purple. *Fossombronia*
Plants with *Nostoc* colonies, rhizoids hyaline .... *Blasia*

7 Plants bearing a tuber at the apex 8
Plants without apical tubers 9

8 Plants with dorsal lamellae, growing in the plains .... *Petalophyllum*
Plants without dorsal lamellae, growing in the hills .... *Sewardiella*

9 Sex organs on small shoots 10
Sex organs on ordinary main shoots 11

10 Fertile shoots small, ventral; midrib distinct, narrow; wing, one cell thick .... *Metzgeria*
Fertile shoots small, lateral; wing thick .... *Aneura*

11 Plants thin, under or near water sex organs without scales, antheridia in pits .... *Pellia*
Plants only on moist places, sex organs with scales, antheridia not in pits .... *Calycularia*

12 Capsules embedded in the thallus 13
Capsules in involucres, not embedded in the thallus 14

13 Thallus with long, lanceolate, purple scales on the ventral side, antheridia aggregated.................... *Ricciocarpus*
Thallus with small often fugaceous scales on the ventral side, scales sometimes absent, antheridia scattered.... ....*Riccia*

14 Plants large, under or near water, no chambers and pores.. *Dumortiera*
Plants in moist or dry places, and always with air-chambers and pores.......................................15

15 Plants with gemmae-cups.......................................16
Plants without gemmae-cups.......................................17

16 Gemmae-cups goblet-shaped.......................................*Marchantia*
Gemmae-cups lunate.......................................*Lunularia*

17 Archegonia in a tubular bivalved involucre just under the apex.......................................18
Archegonia in stalked or sessile receptacles.......................................19

18 Plants robust, large; involucre purple; scales conspicuous *Targionia*
Plants delicate, small; involucre hyaline; scales minute *Cyathodium*

19 Both male and female receptacles stalked.......................................*Preissia*
Male receptacle sessile or antheridia sunken in the thallus.....20

20 Female receptacle distinctly dorsal.......................................21
Female receptacle terminal, marginal, or in the fork between two lobes.......................................22

21 Male receptacle circular or horse-shoe-shaped...*Plagiochasma*
Antheridia sunken in the dorsal tissue of the thallus, papillae projecting.......................................*Athalamia*

22 Female receptacle terminal, with a characteristic perianth.......................................*Fimbriaria*
Female receptacle without a perianth.......................................23

23 Female receptacles terminal, stalked, on small ventral shoots, arising from the midrib on either side......*Grimaldia*
Female receptacles terminal on the main shoots.......................................24

24 Antheridia on the dorsal side of the thallus, no definite male receptacles.......................................25
Antheridia in a definite, sessile male receptacle.......................................30

25 Female receptacle sessile, with 1 or 2 involucres, plants small, air-chambers empty.......................................*Aitchisoniella*
Female receptacle stalked.......................................26

26 Female receptacle in the fork between two lobes: involucres 2 .... *Exormotheca*
Female receptacle terminal, at least when young 27

27 Female receptacle terminal, becoming dorsal by continued apical growth; apical tubers present .... *Stephensoniella*
Female receptacle always terminal 28

28 Plants compact, scales of the female receptacle large, pores starlike with thick radial walls of cells bounding these .... *Sauteria*
Plants spongy or thin, scales inconspicuous, pores bounded by cells with thin radial walls 29

29 Plants thick, spongy; female receptacle convex .... *Sauchia*
Plants thin, flat; female receptacle flat .... *Cryptomitrium*

30 Female receptacle conical, dorsal surface with distinct reticulations and distinct pores .... *Conocephalum*
Female receptacle hemispherical, dorsal surface smooth 31

31 Plants near water, yellowish green, ventral surface of the same colour .... *Wiesnerella*
Plants in moist or dry places, deep green, ventral surface purple 32

32 Female receptacle hemispherical, with 7 to 9, rarely fewer, lobes .... *Reboulia*
Female receptacle flat, cruciate, with 4 involucres. *Massalongoa*

Note:—When a genus has been determined with the help of the above key, it should be confirmed by comparison with the full description.

Order I.

ANTHOCEROTALES.

Family I. ANTHOCEROTACEAE

Gametophyte a thallus, without air-chambers and scales, but possessing slitlike pores on the under surface. Each cell with a large chloroplast. Rhizoids smooth. Antheridia in clusters, in closed cavities near the dorsal side. Archegonia embedded in the tissue of the thallus on the dorsal side. Sporogonium with a bulbous foot, a growing region, and a long capsule dehiscing from the apex downwards by two valves. Columella usually well-developed, of 16 rows of cells (except in *Notothylas* where the columella is often absent), arched over by the archesporium. Capsule wall usually green, stomatiferous. Sterile cells simple or branched, mixed with the spores. *Nostoc* colonies are found embedded in the thallus.

ANTHOCEROS L.

Anthoceros L , Sp. Pl. p. 1139 (1753).

Thallus suborbicular, variously lobed, with the lobes more or less divided, of several layers of uniform cells in the middle, almost always without a sharply defined midrib. *Nostoc* colonies scattered in the thallus. Antheridia in closed chambers. Involucres dorsal, cylindrical. Capsule linear, bi-valved, much longer than the involucre. Epidermis of the capsule wall usually with stomata. Columella well developed. Pseudo-elaters with or without (Himalayan species) spiral bands. Spores usually with various projections.

Key to the species.

1	Plants monoecious	2
	Plants dioecious	3
2	Plants light green, thin,	*A. Gollani*
	Plants dark green, subturbinate	*A. Longii*

3 Plants usually erect or ascending, spores 30-40 μ.......... *A. erectus*
Plants prostrate.. 4
4 Spores yellow, tetrahedral, 25 μ............................ *A. himalayensis*
Spores opaque, faintly granular, 40-48 μ................ *A. chambensis*

1. **Anthoceros erectus** Kashyap.

Anthoceros erectus Kashyap, New Phyt. Vol. XIV, p. 9 (1915).
Anthoceros Butleri St., Sp. Hep. Vol. V, p. 986 (1916).

Plants dioecious, in dense clusters on damp earth. Thallus thick, fleshy, cavernous, often raised on a thick stalk-like structure and expanding above into a more or less cuplike body; more generally ascending or prostrate, fan-shaped, margin arising from the base as if diverging owing to a split. Deeply lobed, up to 10 mm. broad, margin slightly toothed. Male plants smaller. Involucres often fused in pairs, about 5 mm. long and 0·8 mm. in diameter; mouth truncate. Capsule slender, acute, up to 30 mm. long, wall with stomata. Spores black, granulose, 30-40 μ. Pseudo-elaters thin-walled, simple or branched, about 12 μ. broad.

Hab. Moist earth.

Distrib. Outer and Kumaon Himalayas, 5,000 to 8,000 feet. *Mussoorie*, etc., Kulu, *Manali*; S. India, *Madras* (Iyenger, Fyson); Travancore (Krupp).

Note:—From the description *A. Butleri* St. appears to be this plant, although he says it is dioecious. The plant can be easily recognised not only by its habit but also by the large chambers in the thallus filled with mucilage (not air) lumps of which come out when the plant is cut. In sections these chambers are very easily seen. The chambers are met within the involucre also where they are in one layer all round. In a transverse section of the involucre they appear in a circle round the capsule and inside the tissue of the involucre. The rhizoids are filled with some granular matter.

This species is apparently annual—one of the very few annual liverworts. The plant is interesting on account of its peculiar habit. It is often raised on a distinct stalk, the base of which may be thick or pointed. More often it has the appearance as if a funnel has been split along one side. Specimens from *Madras* (Fyson) have slightly larger spores (45 μ). They have, moreover, minute spines on the surface which is merely granulose in the Himalayan specimens.

2. Anthoceros himalayansis Kashyap.

Anthoceros himalayensis Kashyap, New Phyt. Vol. XIV, P. 8 (1915).

Dioecious. Closely attached to the substratum, green, black when dry, in large patches among moss and grass. Thallus variable in size; sterile plants long, linear, forked, about 5 mm. long and 1 mm. broad, tuber bearing; male plants smaller than the female plants and less divided; female plants large, circular, up to 20 mm. in diameter, deeply lobed, lobes again with divided margins and overlapping. Involucres often fused in pairs, cylindrical, slightly narrowed above, mouth usually truncate or indistinctly irregularly toothed, surface smooth, up to 5 mm. long. Capsule stout, cylindrical, obtuse, up to 30 mm. long, with stomata on the wall. Spores yellow, tetrahedral, convex surface with small rounded papillae, 25 μ. Pseudo-elaters thin-walled, branched, occasionally some simple, 10 μ broad.

Hab.	Moist shady places.
Distrib.	Common throughout the Outer and the Kumaon Himalayas, 5,000 to 8,000 feet. Rarely in *Lahore.*

Note:—The plant bears rounded tubers. They are usually borne on sterile plants, at the apex, on the margin, or the ventral surface; occasionally on male and female plants also. They are sometimes embedded in the thallus but more often arise on long cylindrical stalks from the ventral surface or from the margins. The stalk may be up to 3 mm. long and the tuber up to 0·5 mm. in diameter. If the plants are growing among dense grass the tubers are mostly marginal and shortly stalked. Both the tuber and the stalk have some rhizoids.

The rhizoids in this species as well as in the other species of the genus are usually filled with granular matter.

This species is very variable in shape as stated in the description. Occasionally it grows under water and then forms dense patches of overlapping plants. Seen by themselves it would be impossible to refer them to this species, but a careful

PLATE I.

ANTHOCEROS ERECTUS. 1—4.

1. Five plants showing various forms.
2. A plant bearing sporogonia.
3. Spores. 4. Pseudo-elaters.

ANTHOCEROS HIMALAYENSIS. 5—8.

5. Sterile tuber-bearing plants.
6. A plant bearing sporogonia.
7. Spores. 8. Pseudo-elaters.

examination of intermediate forms leaves no doubt about it. The plants growing under water are always sterile.

3. **Anthoceros chambensis** Kashyap.

Anthoceros chambensis Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXV, p. 281 (1917).

Dioecious. Plants closely creeping, firmly fixed to the soil, in dense circular or irregularly-lobed patches. Lobes thick, fleshy, cavernous, with large mucilage cavities inside, often overlapping; margin slightly raised, toothed. Patches up to 3 cm. or more in diameter. Lobes up to 1 cm. broad and up to 16 cells thick in the middle. No distinct midrib. Epidermal cells 32 μ × 20 μ. Rhizoids mostly smooth, some granular. Male plants not seen. Involucres tubular, narrowed above with a truncate mouth, 2·5 mm. long. Capsule 25 mm. long, solitary. Spores opaque, faintly granular, 40-48 μ. Pseudo-elaters thin-walled, usually branched, up to 100 μ long: slender.

Hab. Moist rocks.

Distrib. Chamba Valley; Punjab, *Sialkot* (Bishambar Das).

Note:—Material poor. Requires more careful examination. Perhaps the same as *Anthoceros Gollani* St.

The following species have been described by Stephani but have not been seen by me.

4. **Anthoceros Gollani** St.

Anthoceros Gollani St., Sp. Hep. Vol. V, p. 987 (1916).

Monoecious. Plants small, light green, thin, cavernous. Thallus about 10 mm. long, oblong, furcate, lobes ligulate, regularly inciso-lobate. Involucres solitary, 4 mm. long, cylindrical, cavernous. Capsule 3 cm. long, thin, densely stomatiferous. Spores pale, almost smooth, 36 μ. Antheridia near the involucre, 2 in each chamber, chambers many.

Hab. Himalaya.

Note:—See remarks under *A. chambensis* above.

5. Anthoceros Longii St.

Anthoceros Longii St., Sp. Hep. Vol. V., p. 1003 (1916).

Plants monoecious, small, deep-green, subturbinate, frond about 5 mm. long, obcuneate, ascending. cavernous, repeatedly furcate, base thickened, margins thin, branches regularly narrowly lobed. Involucre solitary, 2 mm. long, delicate, cavernous, cylindrical, plicate. Capsule 2 cm. long, filiform, sparsely stomatiferous. Spores 45 μ. black, asperous. Androecia near the involucre, numerous, many antheridia in each cavity.

Hab. Himalaya, *Simla.*

Note.—Probably identical with *A. erectus* Kashyap, though the latter is dioecious.

* * * *

II. NOTOTHYLAS Sull.

Notothylas. Sullivant, Amer. Acad. of arts and sciences New Ser. Bd. III (1848).

Plants thallose, thin, prostrate, furcate, very much branched, thick at the base, gradually becoming thin, one layered in the ultimate lobes. Androecial chambers often solitary, wide, with 2-4 antheridia in each. Antheridia large, oval, shortly pedicellate. Involucre short, oblong-cylindric, often folded. Capsule marginal, conical, with a large foot, never exserted, bi-valved, valves prominent by deeper colour or owing to the special cells along their margins. Stomata absent. Columella in the centre of the capsule large or altogther absent. Spores large, tetrahedral, with the convex side papillose. Elaters equal in size or longer than the spores, yellowish, inflated, with spiral or simply oblique bands.

Key to the species.

Columella present, only a single row of special
cells along the margin of each valve............ .... ***N. indica***
No columella, four rows of special cells along
the margin of each valve...... .... ***N. Levieri.***

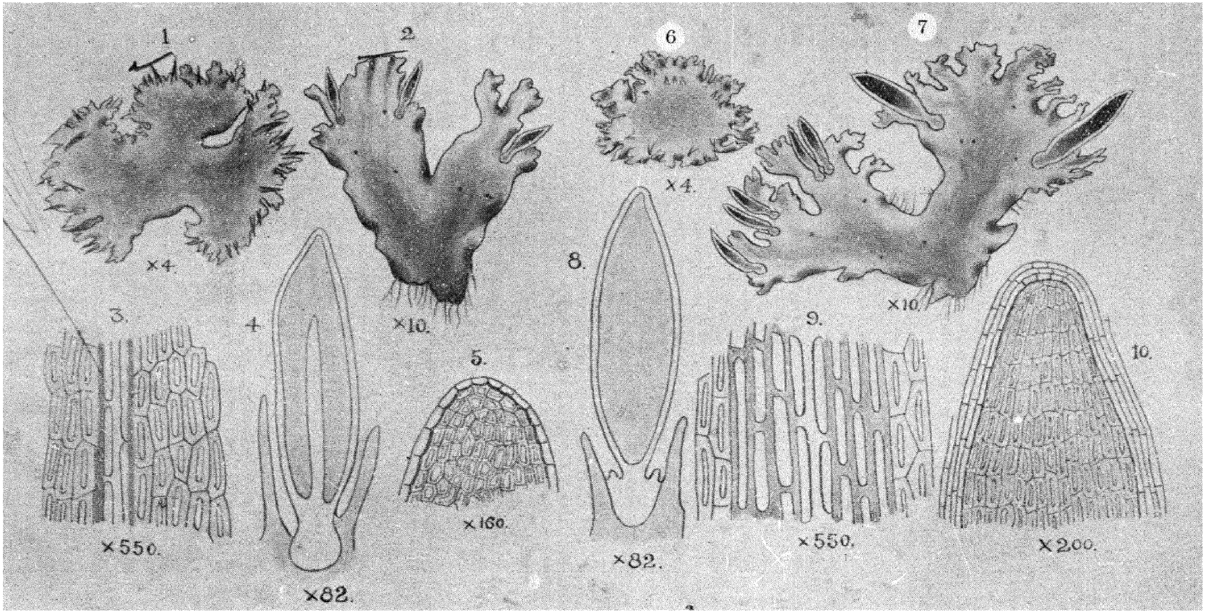

PLATE II.

PLATE II.

NOTOTHYLAS INDICA. 1—5.

1. A plant with sporogonia.
2. A portion of the same magnified.
3. Portion of the capsule wall showing the margins of the valves.
4. L. S. of capsule showing the columella.
5. A portion of one valve. Note the single row of marginal cells.

NOTOTHYLAS LEVIERI. 6—10.

6. A plant with sporogonia.
7. A portion of the same magnified.
8. L. S. of capsule. No columella.
9. A portion of the capsule wall showing the margins of the valves.
10. A portion of one valve. Note four rows of special cells.

6. **Notothylas indica** Kashyap.

Notothylas indica Kashyap, Proceed. Lahore Philosoph. Soc. Vol. IV, p. 54 (1925).

Dioecious. Plants growing singly or densely overlapping in patches. Thallus orbicular or suborbicular in the case of well developed singly growing plants, but in dense patches obovate, lobed, lobes with numerous blunt irregular processes; fully developed plants up to 15 mm. in diameter, lobes up to 6 mm. long and up to 8 mm. broad. *Nostoc* colonies scattered. Thickness in the middle 6 cells; upper epidermal cells 40×50 μ, middle cells 96×112 μ, lower epidermal cells 40×50 μ. Male plants not seen. Sporogonia marginal between the lobes, equal to or smaller than the full grown adjacent lobes, entirely within the involucres which are often in pairs; up to 3 mm. long and 0·5 mm. in diameter. Epidermis without stomata, wall of the cells very thick and brown, lumen fairly large, length of cells near base about 90 μ. and near apex about 30 μ. Capsule with a very definite columella, and only a single row of thick-walled elongated cells along the margin of each valve; marginal cells 120 μ × 18 μ near the base and 32×21 μ at the apex. Spores opaque dark brown, minutely granular, 36 μ. Pseudo-elaters with oblique thin bands, 40 μ × 20 μ.

Hab. Moist rocks and earth.
Distrib. *Dehra Dun*, *Allahabad* (Dudgeon), *Bombay* (d'Almeida).

Note:—This is essentially a species of the plains ascending to about 2,000 feet. The species possesses a long and definite columella and is characterised by two rows of special cells along the suture, so that on separating the two valves, the margin of each valve has one row of these cells.

7. **Notohylas Levieri** Schiff. (Ms).

Notothylas Levieri Schiff. (Ms.), Stephani. Sp. Hep. Vol. V, p. 1021 (1917).

Dioecious. Plants thin, delicate, closely overlapping, in small thick patches, ascending or projecting outwards from vertical rocks. Largest plants circular in outline up to 15 mm.

in diameter, smaller plants usually obovate; margin lobed, lobes narrow small, toothed; *Nostoc* colonies scattered. Greatest thickness up to 6 cells in the middle, gradually thinning towards the single layered margin. Upper epidermal cell 41×46 μ, internal cells 80×96 μ, lower epidermal cells 40×50 μ. Male plants not seen. Sporogonia marginal between the lobes, equal to or smaller than the full grown adjacent lobes. entirely within the involucres which often arise in pairs; up to 3 mm. long and 0·5 mm. thick. Epidermis without stomata; walls of the epidermal cells very thick and brown, cavity very narrow, cells 90—110 μ ×18—20 μ. Columella absent. Four rows of special thick-walled elongated cells along the margin of each valve; marginal cells at the base 160×10 μ, those at the apex 66×9 μ. Spores opaque, dark brown, minutely granular, 36 μ. Sterile cells with oblique, curved, thin bands, or incomplete spirals, 45×22—40 μ.

Hab. Moist rocks.

Distrib. Outer and Kumaon Himalayas, *Simla*, *Mussoorie*, etc. about 6,000 to 7,000 feet.

Note:—The presence of eight rows of special cells along the suture (four rows along the margin of each valve) is characteristic of the species. The cells are markedly different from the rest of the epidermal cells. They are deep brown in colour, very much darker than the neighbouring epidermal cells, their walls are quite straight and their thickness is not so striking though it is considerable. When the valves are separated the outer (free) walls of the marginal cells are found to be thin. It is along these thin walls of the marginal cells that the valves get separated when teased but the capsule, as usual in the genus, does not open under natural conditions, remaining always within the involucre. As the capsule ripens from the apex downwards, the marginal cells also are consequently found at different stages of development in the same order as the spores and elaters. There is no trace of a columella in this species and this character also distinguishes it from *N. indica*. Moreover this is a hill species occurring at higher levels than the latter. In other respects the two are very similar. The remarks about the marginal cells apply to *N. indica* also.

Occasionally a sporogonium may be met with on the dorsal surface instead of being marginal.

ORDER II.

MARCHANTIALES.

FAMILY II. MARCHANTIACEAE.

Dorsal layer with well-developed air-chambers with or without assimilating filaments (exception *Dumortiera*). Pores well defined. Sex organs in groups, often on long stalked receptacles. Sporogonium with a foot and a seta. Elaters present. Dehiscence by a more or less definite lid or valves.

III. MARCHANTIA L.

Marchantia L. Sp. Pl. p. 1137 (1753).

Dioecious. Thallus richly dichotomously branched with a broad midrib and hexagonal areolae. Goblet-shaped gemmae-cups almost always present on the dorsal side of the thallus. Dorsal layer narrow, air-chambers in one layer, the filaments in the chambers frequently branched; pores barrel-shaped. Scales in two or three rows on each side of the midrib, inner ones (median) large, appendiculate; middle (laminar) without appendage, small, more or less ligulate; outer ones (marginal) near the margin, without appendage, small and more or less ligulate. Tuberculate rhizoids are given off from the surface of all the scales in addition to those arising in strands from the midrib. Male receptacle long-peduncled, disciform, stellately or palmately lobed; stalk with two rhizoid furrows on the anterior side. Stalk of the female receptacle with two furrows containing rhizoids on the anterior side and air-chambers on the posterior side; receptacle stellate, with 4—10 elongated rays, each with a rhizoid canal underneath; involucres 2-valved, alternating with the rays, enclosing several capsules, each surrounded by a perianth. Capsule with a long seta, dehiscing to below the middle by irregular valves. Capsule wall of one layer of cells; cells with annular bands. Spores small, tetrahedral, on the convex side irregularly lamellose.

Elaters simple, long, attenuate, bi-spiral. Gemmae more or less biconvex, vertically inserted, with one-celled hyaline pedicel, and an open sinus at each side, in groups at the bottom of goblet-shaped gemmae-cups, margin of the cup shortly lobed or entire.

Note:—The pores on the thallus are barrel-shaped consisting of a few rings of super-imposed cells. Some of these rings are above the level of the epidermis while others are below, but there is no sharp distinction between these as one or two are bound to be opposite the epidermal cells and at the same level. The pores are broad in the middle and narrow above and below and the lower opening is in some cases more or less closed by projections from the bounding cells. In *M. polymorpha* the inner pore is very variable in outline. Usually, however, each of the four or five cells bounding the pore is narrow and its inner wall bulges in its middle inwards into the cavity as a more or less well developed papilla which sometimes becomes very long giving the pore a cruciate appearance. In *M. nepalensis* the inner wall of the bounding cells projects into the cavity of the pore very greatly and the pore is distinctly cruciate. In *M. palmata* the bounding cells are narrow with a straight or slightly convex inner wall and is therefore quadrate in appearance. Stephani describes the pore of *M. simlana* also as quadrate but I have not seen any specimens of this species.

Key to the species.

Inner pore quadrate bounded by narrow cells.
  Thallus with a median dark streak..................*M. palmata.*
  Thallus without a median dark streak..............*M. simlana.*
Inner pore cruciate ....*M. nepalensis.*
Inner pore bounded by narrow cells with a
  more or less well developed convex papilla
  from the middle of the inner wall of each cell.
M. polymorpha.

8. Marchantia polymorpha L.

Marchantia polymorpha L., Sp. Pl. p. 1137 (1753).

Dioecious. In large extended deep green patches. Thallus 2-10 cm. long, and 7-20 mm. broad, flat or slightly concave, margins sinuate-lobed, apex emarginate. Dorsal surface with frequently a dark line along the middle; areolae somewhat distinct, epidermal cells 5-6-angled, walls thin, angles not thickened. Pores not visible to the naked eye, little elevated, with 5 superimposed concentric rings each of 4-5 cells, appearing oval from above, with 2-3 rings of cells above the level of the epidermis; inner pore quadrate to cruciate as seen from below, usually wide, bounded by 4 or 5 narrow cells the middle part of whose inner walls projects into the cavity of the pore as a convex papilla which is sometimes greatly elongated. The cells of the lowest ring rather elongated and projecting into the cavity of the inner pore as seen in a vertical section of the pore. Ventral surface brownish. Scales in three rows on each side of the midrib. Median scales largest, attached by a not very long base, appendage sub-rotund with an irregularly toothed margin; laminar scales more than half way from the midrib, without appendage, ligulate; marginal scales smallest, ligulate. Midrib scarcely prominent below, very gradually passing into the lamina, ending in a one-celled margin. Male receptacle with 8 short rounded lobes; stalk shorter than that of the female receptacle, air-chambers absent. Stalk of the female receptacle 3-5 cm. long, with air-chambers on the dorsal side. Spores spherical, 12 μ, nearly smooth. Elaters bispiral, long and narrow. Margin of gemmae-cup shortly-lobed, lobes triangular, acuminate, with a spinous margin.

Hab. Moist rocks and banks of streams.

Distrib. Common above 8,000 ft. Garhwal, *Kedar Nath* (11,000 ft.); Pangi; Ladakh, *Leh*, *Kargil;* beyond Bara Lacha pass about 15,000 feet.

Note :—The marginal scales are not arranged in one regular row but occur rather irregularly and very closely together, more or less overlapping. They do not correspond to the median or laminar scales in position and are more numerous than these.

The cells of the inner pore are long and narrow, the middle part of the inner wall of the cells projects inwards into the cavity of the pore as a convex papilla. The size of the papilla is variable. In most cases it is quite small so that the papillæ do not meet in the centre and a very large part of the cavity remains empty. In some specimens from Leh, however, these papillæ were very long and almost meeting in the centre, leaving large empty spaces between their lateral walls.

The specimens from Leh are further characterised by the possession of a dark streak along the middle line, and the specimens, therefore, resemble the *forma aquatica* Nees. The dark median line, however, has chambers which are said to be absent in that form.

The Pangi specimens show another peculiarity. The thallus is much elongated, and the anterior margin of the gemmæ-cup is mostly fused with the thallus and only slightly raised above it, giving the cup a superficial resemblance to the gemmae receptacle of *Lunularia*.

9. **Marchantia palmata** Nees.

Marchantia palmata Nees. Nova Acta XII, p. 193 (1824).

Dioecious. Plants medium, green, growing in patches. Thallus 3-7 cm. or more long, dichotomous, with long narrow lobes 2-10 mm. broad, flat, margin entire, apex emarginate. Dorsal surface with a dark line in the middle; epidermal cells 5-6-angled, walls thin, angles not thickened. Pores with 6 superimposed concentric rings, each of 4-5 cells. 2 rings above the level of the epidermis, cells of the lowermost ring small, not projecting into the cavity of the inner pore as seen in a vertical section of the pore; inner pore quadrate as seen from below, bounded by 4 or 5 cells which are narrow and do not project into the pore. Ventral surface brown. Scales in two rows on each side. Median scales fixed by an oblique semilunar longly decurrent base, appendaged, appendage sub-rotund to ovate, coarsely and irregularly toothed; laminar scales without appendage, more or less quadrate; marginal scales absent. Midrib scarcely prominent below, gradually passing into the lamina ending in an acute margin. Male receptacle more or less circular with many short lobes, or palmatifid with long narrow diverging lobes, in the latter case 3-9 lobed; stalk 10-20 mm. long, air-chambers present on the dorsal side near the base. Stalk of the female receptacle up to about 35 mm. (mostly 20 mm.) long, green, with air-chambers on the posterior side; receptacle asymmetrical, deeply rayed, rays 7-11, narrow, slightly convex or flat, truncate or slightly emarginate. Involucres hyaline, margin crisped. Perianth purple. Capsules spherical, dark brown, several in each involucre. Spores yellowish brown, reticulate, 24-30 µ. Elaters 540 to 630 µ. Gemmae-cups rather rare, margins shortly irregularly ciliate dentate.

Hab. Moist rocks and water banks.

Distrib. Common in the Kumaon Himalayas and the Outer Himalayas up to Kashmir, up to 8,000 feet; fairly common in the plains, *Lahore, Sialkot; Calcutta;* Assam (S. L. Hora); South India (Iyengar). Often growing mixed with *M. nepalensis.*

Note:—The lobes are usually long and narrow and with a distinct dark line in the middle on the dorsal side. It can easily be distinguished from *M. nepalensis* by its narrow lobes with the dark mid-dorsal line and the female receptacles not being umbonate. The plant has a definite mycorrhizal region in the central part of the thallus. In a specimen from Lahore the stalk of the carpocephalum was seen to divide into two near its upper end. The undivided lower portion was 5 mm. long, while each of the branches was 1 mm. long. Each branch had a perfectly normal receptacle at its top. The main stalk showed four rhizoid furrows in two pairs, while each of the branches had one pair. Another specimen from Mussoorie showed that a lobe of the male receptacle after forming antheridia for sometime had begun to form ordinary vegetative tissue with even a gemmae-cup. The same specimen had an ordinary vegetative shoot arising from the ventral surface of another lobe of the male receptacle.

The male receptacle is very variable in form. The stalk sometimes possesses four furrows instead of two. The receptacle itself may be almost entire with a very slight indication of lobes or the lobes may be very long and narrow and diverging from each other.

Rhizoids of various diameters are met with, from 5 to 30 µ, and vary in colour from perfectly hyaline to bright yellowish brown. The narrow~~ish~~est rhizoids have long and short densely situated tubercles and are colourless. Others, a little broader, have rather thinner walls and are studded with tubercles and are either hyaline or are slightly yellowish brown. Still wider ones may have tubercles in one part and may be smooth in the remaining part, or may have a few small indistinct blunt tubercles scattered here and there and usually have a distinct yellowish brown colour and very thick walls. Still others have extremely thick smooth walls and show no trace of tubercles. Some rhizoids of the large diameter are also met with which have smooth and thin walls. The walls of all the rhizoids except those of the last group are thick proportionately to the diameter. The scales usually have club-shaped mucilage cells projecting from the margin. The thallus usually has thick walled wide elongated (sclerotic) cells in the midrib, sometimes, however, these cells are practically absent. The number of cells bounding the inner pore may vary from 3 to 10, though usually it is 4 or 5.

10. Marchantia nepalensis L. et L.

Marchantia nepalensis L. et L. in Lehm. Pug. IV. p. 10 (1832).

Dioecious. In large patches of overlapping individuals. Branching richly dichotomous. Thallus larger in female plants, 18-30 mm. long and 6-12 mm. broad; lobes short and broad; flat, margin entire to crisped, apex emarginate. Dorsal surface pale green, without a dark median streak; areoles conspicuous; epidermal cells 5-6-angled, walls thin, angles not thickened. Pores with 6-8 superimposed concentric rings of cells, each of 4 or 5 cells, 2 rings above the level of the epidermis, the cells of the lowermost ring very long and projecting into the cavity of the inner pore as seen in a vertical section of the pore. Inner pore cruciform as seen from below, bounded by 4 or 5 cells projecting into it. Ventral surface brownish. Scales conspicuous, in two rows on each side of the midrib; median scales fixed by a long oblique semilunar decurrent base, appendaged, appendage ovate to ovate-lanceolate, tapering to an acute apex, distantly and irregulary toothed, sometimes almost entire; laminar scales very close to the median scales, ligulate, small; marginal scales absent. Midrib not prominent below, gradually passing into the acute margin. Male receptacle slightly lobed, lobes 6-8; stalk 3-6 mm. long, air-chambers absent. Stalk of the female receptacle 3 cm. or more long, green posteriorly, with air-chambers, brown anteriorly, beset with scales at its base. Receptacle umbonate, with 7-9 rays, rays obcuneate, strongly convex in the proximal part, thin and flat distally, apex crenate or occasionally emarginate. Involucres hyaline, fimbriate. Capsules pedicellate, several in each involucre. Spores brown, granular, 18-25 μ. Elaters

PLATE III.

MARCHANTIA POLYMORPHA. 1—5.

1. A male plant.
2. A female plant.
3. A gemmae-cup.
4. A pore from above.
5. Two pores from below.

MARCHANTIA NEPALENSIS. 6—10.

6. A female plant.
7. A male plant.
8. Vertical section through a pore.
9. A pore from above.
10. Two pores from below.

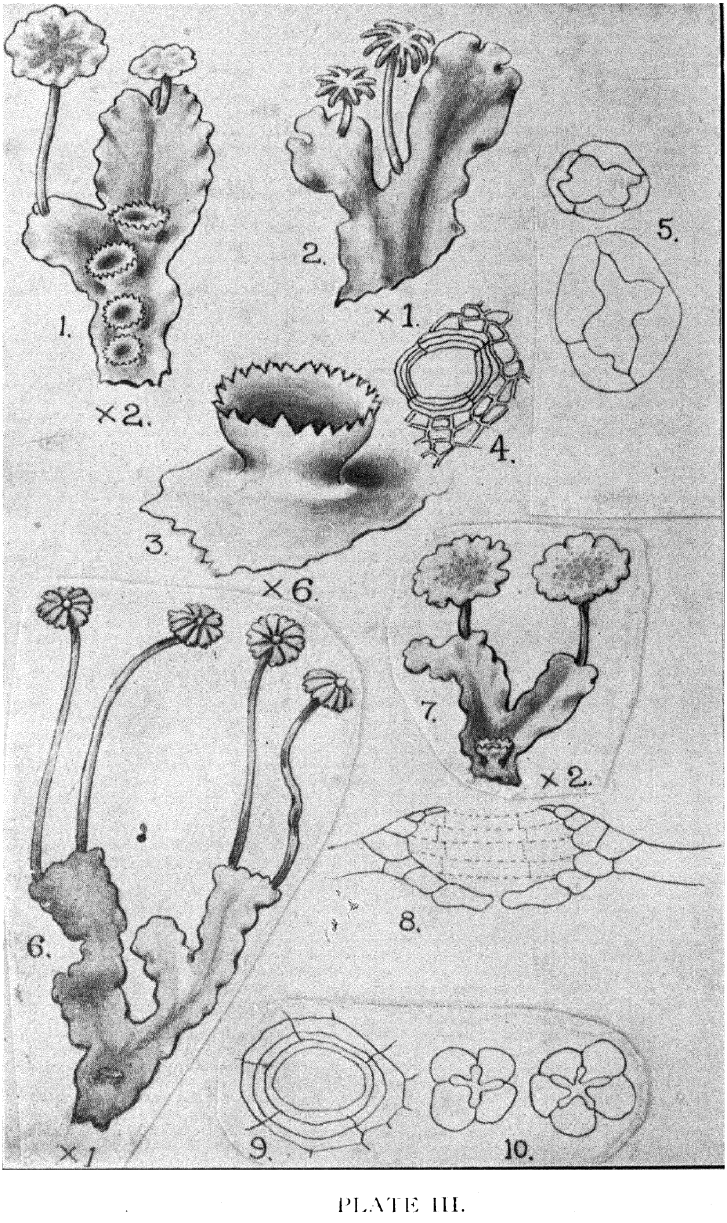

PLATE III.

400 to 640 µ. Gemmæ-cups lobed, lobes deltoid, acute to acuminate, dentate to shortly spinose on the margins.

Hab. Moist rocks and water banks.

Distrib. Common in the outer Himalayas up to Kashmir, Garhwal and Kumaon, up to 8,000 feet; Punjab plain, *Lahore* etc.; Kaghan Valley (N. A. Qizilbash). Often growing mixed with *M. palmata.*

Note.—In the Kaghan Valley specimens apical adventitious shoots are present. Variations are met with in the rhizoids of this species also as described in the preceding species. The thallus possesses sclerotic cells and a mycorrhizal region as given under *M. palmata.* Oil-cells are found in the thallus in both the species. The plant can be distinguished from *M. palmata* by the absence of the median dorsal dark streak, by its generally broader and shorter lobes, the cruciate inner pore and the umbonate female receptacle.

The following species has been described by Stephani but not seen by me.

11. **Marchantia simlana** St.

Marchantia simlana St., Sp. Hep. Vol. I, p. 173 (1899).

Small, light green, ventral surface purple, up to 2 cm. long and 4 mm. broad, thin, midrib low, not prominent, gradually passing into the wings. Epidermal cells thin, delicate. Stomata large, slightly prominent; inner opening bounded by 5 narrow cells. Appendage of the scales large broadly ovate, acute, margin slightly crenulate, marginal cells small. Male receptacle not seen. Stalk of the female receptacle thin, short, 10 mm. long, naked, apex covered with filiform scales, scales of the involucre broadly lanceolate-cuspidate, or longly setaceous. Female receptacle small, 9-lobed, central disc large, lobes as large as the disc, linear, rather flat and distant; apex slightly cuneate, expanded. Involucres hyaline, lobate, lobes fimbriate. Rest not seen.

Hab. Himalaya, *Simla.* (Brandis).

* * * *

IV. PREISSIA Corda.

Preissia Corda in Opitz, Beitr. I p. 647 (1829).

Monoecious or dioecious Plants dichotomous, fertile ones with innovations from the apex. Air-chambers distinct, filled with filaments; pores barrel-shaped. Ventral scales large, in two rows. Male receptacle stalked (stalk shorter than that of the female receptacle), circular with a membranous margin, with scales on the under surface, stalk with 2 rhizoid furrows. Stalk of the female receptacle long, with 2 rhizoid furrows; receptacle hemispherical, with 3-5, usually 4, cruciate rays; involucres from the under surface alternating with the rays; perianth present. Foot large, seta distinct, capsule slightly exserted, subglobose, wall one-layered, cells with annular bands, dehiscing to about the middle by irregular, revolute valves, the cap breaking up. Spores reddish-brown, coarsely reticulate. Elaters yellowish, filiform.

12. **Preissia quadrata** (Scop.) Nees.

Preissia quadrata Nees, Eur. Leb. IV p. 135 (1838).

Monoecious or dioecious. Plants in thin pale green patches. Thallus up to 3 cm. long and 5-10 mm. broad, nearly flat above or with a dorsal groove, margin thin wavy reddish brown entire or crisped, innovations obcordate, bilobed. Dorsal surface with distinct areolae, epidermal cells 4-6-angled, mostly quadrate at the margins, thin-walled, angles not thickened, pores small, somewhat conspicuous, with 4 to 5 super-imposed concentric rings of cells, circular above with 2 rings, each of 4 to 6 cells, cruciate below with 3 or 4 larger cells Ventral surface reddish brown, scales imbricate, in one row on each side of the midrib, semilunar, with minute lanceolate appendages. Midrib prominent below, containing longitudinal brown fibrous cells, rather suddenly passing into the lamina, ending in an acute margin. Stalk of the male receptacle up to 2 cm. long. Stalk of the female receptacle up to 5 cm. long, reddish-brown below. Receptacle usually 4-, often 5-lobed, with 4 or 5 involucres, each with a single capsule. Perianth inflated. Capsule wall of one layer of cells with numerous annular or spiral bands, lid dark brown.

PLATE IV.

MARCHANTIA PALMATA. 1—7.

1. A female plant.
2. A male plant.
3. A gemmae-cup.
4. A pore seen from below.
5. Two pores from above.
6. T. S. of stalk of the female receptacle.
7. A male receptacle, with two adventitious vegetative lobes.

PREISSIA QUADRATA. 8—11.

8. A female plant.
9. A male plant.
10 V. S. through the pore,
11 A pore from above.

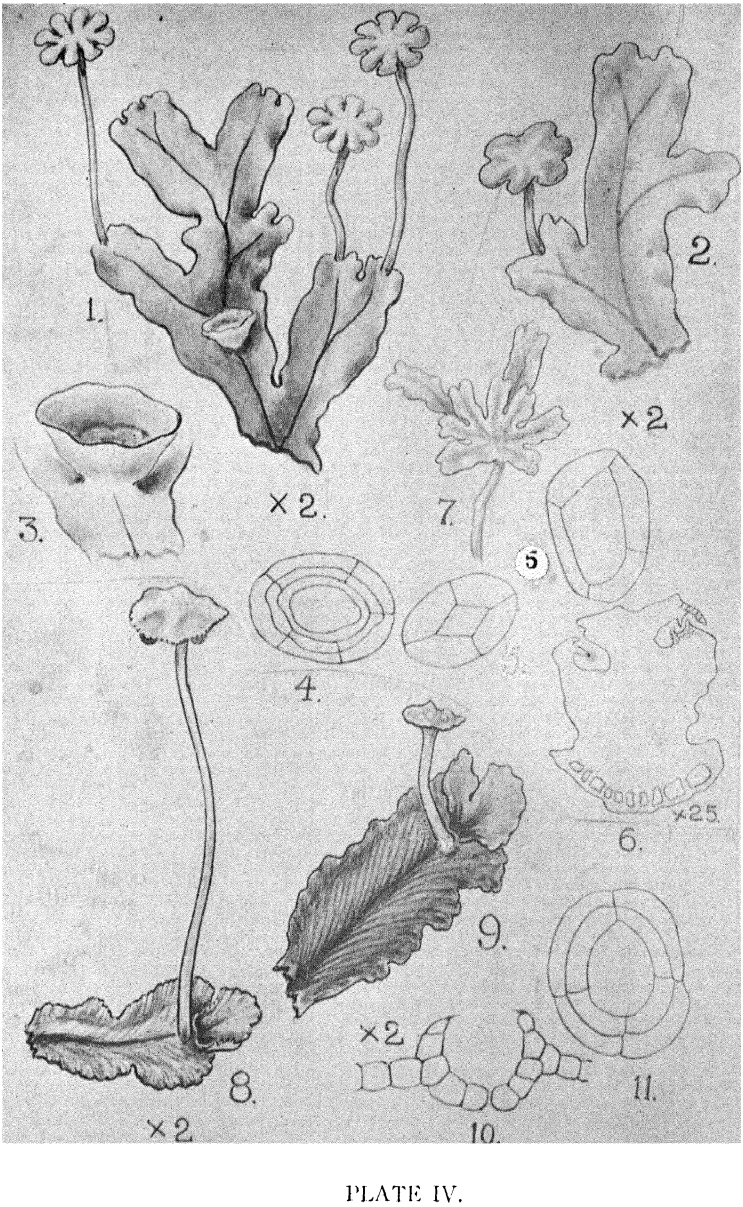

PLATE IV.

Spores 58 to 74 μ in diam., reddish brown, coarsely reticulate. Elaters bi- or tri- spiral, reddish brown, 250 to 290 μ long.

Hab. On moist soil or rocks.

Distrib. Pangi, very common; Lahul; beyond Baralacha Pass, below *Kinlung* at about 15,000 feet; Kashmir, *Asthanmarg* (M. L. Sethi); Kaghan Valley (N. A. Qizilbash). Not met with in the Outer Himalayas at the ordinary hill stations, rare in the Ravi valley.

Note:—The receptacle is usually 4-lobed, with 4 sporogonia at maturity but 5 sporogonia are not uncommon and in specimens from the Kaghan Valley 6 sporogonia were seen in a receptacle.

The receptacles are terminal but growth of the thallus is continued by an adventitious shoot formed at the apex at the base of the stalk. The stalked circular male receptacle with a membranous margin is also characteristic.

When the pore is seen from above quite a broad membrane is seen projecting into the cavity of the pore. Short and broad elater-like cells with spiral or annular bands are found fixed to the base and apex of the capsule and projecting into the cavity, usually about 120-160 μ long and 40 μ broad at the base gradually tapering to an obtuse apex, with a few distant bands. Some are even shorter and without annular bands.

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V. WIESNERELLA Schffn.

Wiesnerella Schffn. Oest. Bot. Zeitschr., p. 1 (1896).

Plants thallose, large, terrestrial, light green, prostrate, delicate, in large extended patches. Fronds monopodially or dichotomously branched, lobes oblong to quadrate. Dorsal surface more or less flat, chambers small, distant, densely filled with rudimentary filaments; pores simple, slightly raised. Ventral scales large, hyaline. Male receptacle in the mid-dorsal groove of the female branch, subsessile, cushion-like, surrounded by scales. Stalk of the female receptacle arising from a deep narrow notch at the apex; thin, hyaline, naked or surrounded at the base by a few scales, 2-furrowed. Receptacle convex, papillose, stomata compound; with 5-8 (normally 6) long narrow radii alternating with the lobes. Involucres under the lobes, bilabiate, lips entire. Perianth nil. Archegonia up to four in each involucre. Capsule longpedicelled, exserted, spherical, dehiscing by 4-6 irregular revolute valves to the middle. Wall cells brown, 1-layered, with annular bands. Spores reticulate, winged. Elaters long and narrow.

13. **Wiesnerella denudata** (Mitten) St.

Wiesnerella denudata (Mitten) St., Sp. Hep. Vol. I, p. 154. (1899).

Monoecious. In large extended yellowish green or light green patches, of irregularly overlapping individuals. Thallus thin, dichotomous, 2 cm. long and 1 cm. broad, nearly flat above, margin wavy, lobes oblong to quadrate, notched at the apex. Dorsal surface with distinct areolae, epidermal cells 5-6 angled, walls not thickened, angles thin. Pores large, slightly convex, formed by 4 series of 6 cells each. Ventral surface brownish; scales oblique, lunate, large, hyaline, in one row on each side, appendage large, subrotund, strongly constricted. Midrib narrow, distinct, passing into the wings gradually. Male receptacle in the mid-dorsal groove of the thallus behind the stalk of the female receptacle, forming a circular cushion, sub-sessile or shortly peduncled, surrounded by short brown ligulate scales. Stalk of the female receptacle terminal, arising from a narrow notch, 4 cm. long, often shorter, thin, hyaline, naked, or surrounded at the base by a few lanceolate, deciduous scales, shortly 2-furrowed. Receptacle convex, 6-lobed, with 6 involucres. Perianth nil. Capsule long-pedicelled, exserted, spherical, dehiscing by 4 irregular valves. Cells of the capsule wall brown, with annular bands. Spores reticulate, winged, wing broad, lobed, wavy, 40 μ in diam. Elaters narrow, bispiral, 340 μ long.

Hab. Very moist rocks, or actually under water.

Distrib. *Dalhousie-Khajiar* road, Dulchi pass, about 6,500 feet.

Note:—The plant has been found by the writer in two places only and without ripe sporogonia. The description of the sporogonium is after Stephani who gives Kumaon also as one of the localities where the plant has been met with. At the localities where it was found by the writer it occurred along with

Conocephalum conicum. Stephani states that the lobes of the thallus are broadly linear but in my specimens they are oblong to quadrate.

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VI. DUMORTIERA Reinw. Bl. et Nees.

Dumortiera Reinw. Bl. et Nees, Nova Acta Leop. Carol. VII p. 410 (1824).

Plants thallose, very large, terrestrial, near streams or actually under flowing water. green, prostrate, overlapping, in large expanded patches. Thallus flat or procumbent, repeatedly dichotomous or branching by apical innovations; apex notched, margin undulate; midrib very prominent; air-chambers absent and cells of outermost layer contain chlorophyll. Scales greatly reduced, hyaline, occurring as narrow long oblique ridges attached to the thallus on each side of the midrib in one row; often present near the apex and absent from the older parts. Male receptacle disciform, depressed in the centre, subsessile, with bristles on the margins, much like the female receptacle in appearance when young. Female receptacle sessile when young, stalked when mature. Stalk long, two-furrowed, base naked, top covered with chaffy scales. Receptacle disciform, convex, umbonate, with a few bristle-like hairs, with 6-10 short lobes, with one saccate, horizontal involucre on the underside of each enclosing a single capsule. Perianth absent. Capsule with a short pedicel, wall one-layered, cells with annular bands, dehiscing by 4-8 valves, with fixed elater-like cells arising from the bottom. Spores tetrahedral, dark brown, warty. Elaters long, 2-4-spiral, sometimes branched.

Note:—Different writers recognise different numbers of species of the genus based on the structure of the thallus, receptacles and involucre among other characters. Stephani describes three species, but Evans maintains that there are only two. Mr. B. L. Sethi, M. Sc., working in this department has examined a large number of specimens from various parts of the W. Himalayas and S. India. He comes to the conclusion that there is but one species which is exceedingly variable. Air-chambers are met with at the apex in plants growing in comparatively less moist places. The pores even in such plants are rudimentary and each is bounded by 4 cells. Chambers are always absent everywhere in plants growing under water or on very moist places. The thallus may be densely covered with papillate cells on the dorsal surface, thus giving it a velvety appearance, the form distinguished as *D. velutina*, or the papillae may be few or wholly absent. The dorsal surface often shows distinct reticulations. Similarly characters based on receptacles are not reliable. Different forms showing the above mentioned variations are often met with in plants growing very near each other, some under water and others just outside; some in shade and others more or less exposed. All the forms, therefore, have been grouped here under one species *i. e.*, *D. hirsuta.*

14. **Dumortiera hirsuta** Reinw. Bl. et Nees.

Dumortiera hirsuta Reinw. Bl. et Nees. Nov. Act. Leop. Carol. VII p. 410 (1824).

Dioecious or monoecious. In extended, dark green, large patches of overlapping individuals. Thallus 4 to 10 cm. long and 8 to 12 mm. broad, repeatedly dichotomous, apex deeply emarginate; flat or slightly concave above, margin undulate;partly or wholly transluscent; with the midrib appearing conspicuous. Dorsal surface sometimes with a faint network, covered densely with papillate cells or with only a few such cells, or perfectly smooth and absolutely without such cells. Epidermal cells 4-6-angled, walls thin, angles not thickened. Ventral surface green, scales simple, hyaline, evanescent, occurring in older parts as narrow, long, oblique ridges attached to the thallus by their entire length in one row on each side of the midrib. Midrib prominent below, about 22 cells thick in the middle, formed of 5-6-angled cells with thick walls, passing very gradually into the lamina formed of large cells. Midrib cells often infected with fungal hyphae. Male receptacle terminal, with bristles on the margin, and much like the female receptacle in appearance when young. Female receptacle sessile when young, with a few bristles, stalked at maturity; stalk thick, reddish brown, with 2 rhizoid furrows, up to 3 cm. long. Capsule globose, reddish-brown, wall of one-layer of cells with numerous annular bands. Spores tetrahedral, dark brown at maturity, densely and finely muricate, 22 to 26 μ in diam. Elaters long, attenuate, 2-4-

PLATE V.

DUMORTIERA HIRSUTA. 1—10.

1. A female plant.
2 A male plant with apical innovations.
3. T. S. of thallus. Epidermis smooth.
4. Portion of T. S. of thallus showing papillate epidermal cells.
5. A pore from near the apex, in surface view.
6. Portion of the stalk of the female receptacle. Note two furrows.
7. A dehisced capsule. Note the fixed elater-like cells at the base.
8. Spores. 9. Short elater-like cells.
10. Elaters; spirals not shown in the branched elater.

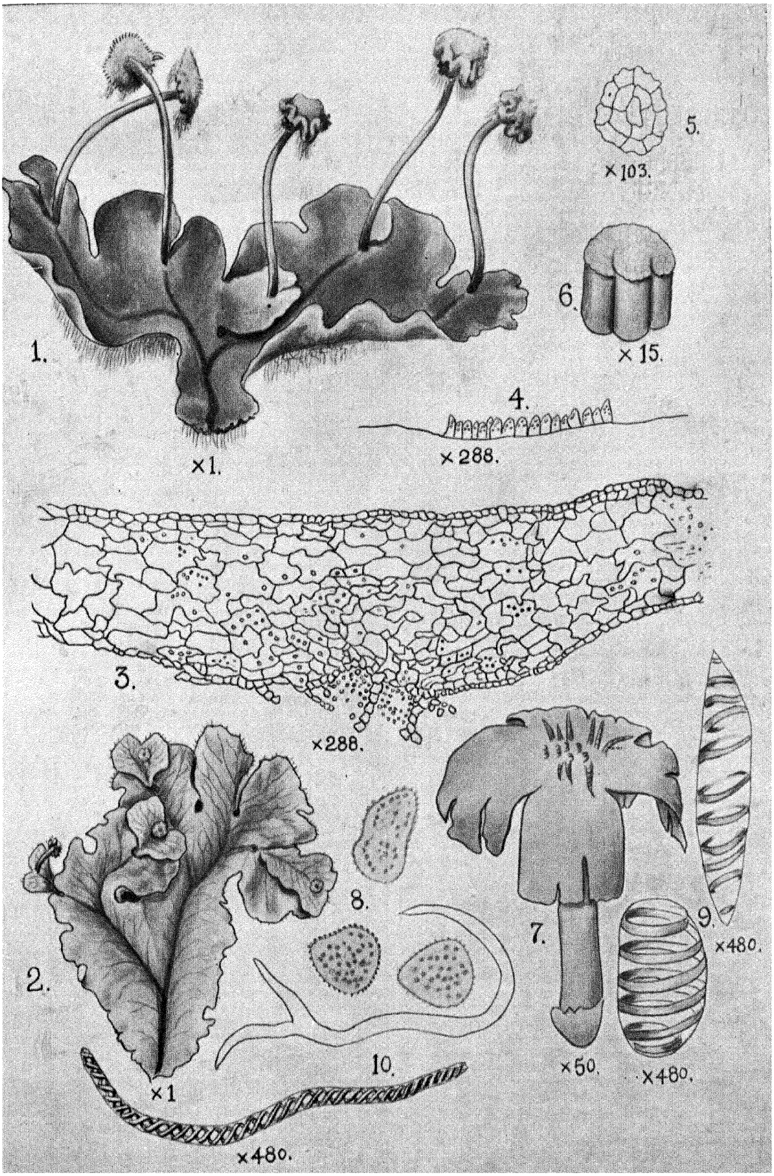

PLATE V.

spiral, some branched, 450 to 900 μ long. Elater-like cells with 1 to 4 spirals, trumept shaped, 50 to 100 μ long.

Hab. On moist earth or actually under running water on stones, on the walls of water reservoirs in rather dark places, in streams, etc.

Distrib. Common, 4,000 to 10,000 feet, in the Kumaon and the Outer Himalayas everywhere; Ravi Valley; Pangi, Lahul; and S. India.

Note:—Kidney-shaped androgynous receptacles are of frequent occurrence, especially in the forms collected from very moist places. These were in all observed cases sub-sessile, with a few or many bristles coming out from the margin and dorsal surface and had no central depression.

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VII. CONOCEPHALUM Necker.

Conocephalum Necker, Elem. Bot. III. p. 344 (1759).
Fegatella Raddi, Opusc. Scient. di Bologna II p. 356 (1818).

Thallus large, dichotomously branched; dorsal surface areolate, areolae very distinct, mostly hexagonal, pores simple. Dorsal layer shallow, air-chambers large, terminal cells of filaments arising from the floor produced into pointed colourless beaks. Male receptacle disciform, papillose. sessile, at the apex of a branch, sometimes apparently lateral, in a cup formed by the growth of the thallus laterally and posteriorly. Female receptacle terminal in a pit; stalk long, with a single rhizoid furrow; receptacle obtusely conical, almost entire, composed of 5 to 8 tubular involucres on the under side, each enclosing a single capsule. Perianth absent. Capsule with rather long pedicel, clavate-pyriform, dehiscing at maturity by throwing off an apical cap, the remainder splitting longitudinally by 4 to 8 reflexed valves. Spores large, papillose, many-celled, beginning to germinate while still within the capsule. Elaters 2-4-spiral, bluntly fusiform.

15· Conocephalum conicum (L.) Necker.

Conocephalum conicum (L.) Necker, Elem. Bot. III. p. 344 (1759).
Fegatella conica Corda in Opiz, Beitr. I. p. 649 (1829).

Dioecious. In large dark green patches. Apical innovations common. Thallus dichotomous, up to 10 cm long and 10 to 12 mm. broad, flat, with somewhat undulate margins; the apex emarginate. Dorsal surface with large conspicuous areolae forming a regular net work; epidermal cells thin walled, angles not thickened. Pores simple, elevated, visible to the naked eye, with 5 to 6 concentric rings of cells, the innermost ring composed of 6-7 cells. Ventral surface pale green, midrib conspicuous, usually with wide tubes scattered in it; scales rather distant, in one row on each side of the midrib, with a violet, reniform or orbicular appendage. Midrib somewhat suddenly passing into the lamina ending in a generally 2-celled margin. Male receptacle sunken in a cup formed by the dorsal growth of the thallus, terminal, or becoming apparently lateral. Antheridia scattered on the dorsal side in between the air-chambers. Female receptacle terminal, sunken (as a whole while young, or base of the stalk when old) in a cup formed by the growth of the thallus laterally and posteriorly. Dense scales below and round the young receptacle. Central part with distinct air-chambers and pores. Capsule wall of a single layer of cells except at the top, with annular bands. Spores green, multicellular, 85 µ. Elaters bluntly fusiform, 170 µ long.

Hab.	Moist cool and shady rocks, usually near running water.
Distrib.	Very common in the Kumaon and the Outer Himalayas up to Kashmir in the west, 5,000 to 8,000 feet; Middle Himalayas; Pangi.

Note:—Specimens from above *Alwas* show no trace of the wide tubes in the midrib. Tuberculate rhizoids occur on the midrib in bundles in the axils of the scales. Cavers states that during one growing season the archegonia are fertilised and the development proceeds till the spore formation, all this time the female receptacle remaining sunk in the cup. At the end of the season the growth stops. Next season at the very beginning the stalk elongates suddenly, the spores are dispersed,

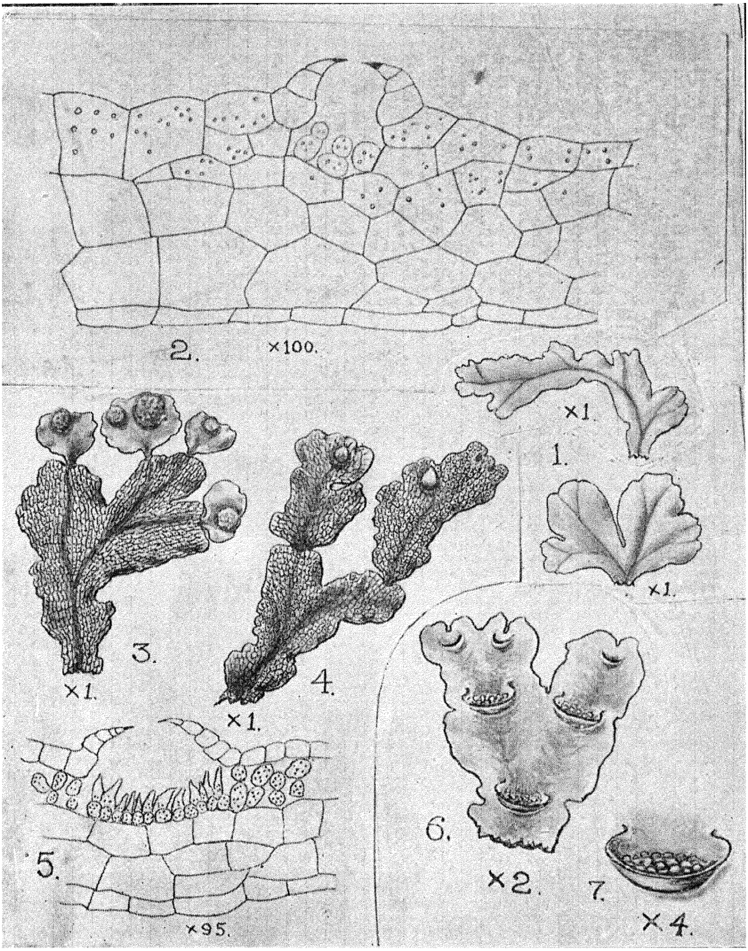

PLATE VI.

and the former dies away. The writer has seldom seen ripe stalked female receptacles in the Himalayas. Male receptacles and young female receptacles are very common. Plants with remnants of the decayed stalk also are often met with. The plant forms extended patches of a dark green colour, sometimes extending over several feet, in moist and shady places. It is often accompanied by *Pellia* and *Dumortiera* and was accompanied by *Wiesnerella denudata* at the places where the latter was met with. It can be readily recognised by the conspicuous reticulations of the dorsal surface, the large scale appendages, the large disc-shaped male receptacles (with conspicuous papillae) inside a cup-like outgrowth and the conical female receptacle. This species is the largest thallose liverwort excepting only *Dumortiera* throughout the Western Himalayas.

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VIII. LUNULARIA Mich.

Lunularia Mich., Nov. Pl. Gen., p. 4 (1729).

Thallus large, irregularly furcate or innovating at the apex. Dorsal surface distinctly areolate when moist,with semilunar gemmae-cups. Dorsal layer narrow. Pores simple; air-chambers in one layer, with filaments. Male receptacle disciform, sessile, at the apex of a short branch, becoming, as with the female receptacle, apparently lateral, surrounded, except in front, by the elevated border of the thallus. Stalk of the female receptacle terminal on a short branch, becoming apparently lateral, without a rhizoid furrow, hairy, surrounded at the base by scales in several layers; receptacle young disciform, later almost always composed of 4 cruciate, horizontal, tubular involucres, each containing a single sporogonium. Perianth absent. Capsule wtih a long pedicel exserted from the bilabiate opening of the involucre, dehiscing nearly to the base by 4 narrow valves. Cells of the capsule wall without annular bands. Spores tetrahedral, yellowish brown. Elaters bispiral, thread-like.

16. **Lunularia cruciata** Dum.

Lunularia cruciata Dum., Comm. Bot. p. 116 (1822).

Dioecious. Plants light green, thin, in large patches of overlapping individuals. Thallus up to 4 cm. long, dichotomously divided; lobes oblong to quadrate 8 mm. broad, deeply notched at the apex, with sinuate hyaline margin. Dorsal surface flat or slightly concave; epidermal cells 5-6-angled, angles and walls not thickened. Pores raised, bounded by 3 rings of 6-8 cells each. Chambers in one layer, containing short branched filaments. Ventral surface green; scales in one row on each side of the midrib, thin, delicate, attached by a long semilunar base, appendage rotundate. Midrib not much prominent below, gradually passing into the wings. Male receptacle sessile, disciform, terminal. Stalk of the female receptacle 2-2·5 cm. long, delicate, nearly pellucid, with scattered hairs or almost naked. Capsule dark brown, oval, wall of one layer of cells, without bands. Spores rounded, tetrahedral, smooth, yellowish brown, 14-17 μ in diameter. Elaters long, slender, yellowish brown, bispiral, 340 μ long. Gemmae receptacles semilunar; receptacle wall very high posteriorly gradually becoming lower forwards, the diameter between two ends being about 6 mm. Gemmae on unicellular stalks, circular, biconvex, margin thin, entire, with two lateral notches with overlapping margins.

Hab.	Moist rocks.
Distrib.	Himalayas, *Darjeeling* (Tirunarayanan); S. India, *Madras*, *Ootacamand* (Iyengar). Not met with so far in the Western Himalayas but may occur in Kumaon.

Note:—All the material available is sterile. Description of receptacles is after Macvicar: "The Student's Handbook of British Hepatics" and Stephani "Species Hepaticarum." Occasionally the anterior margin of the gemmae-cup in *Marchantia* remains rudimentary and the cups bear a certain resemblance to the semilunar gemmae-receptacles in this species.

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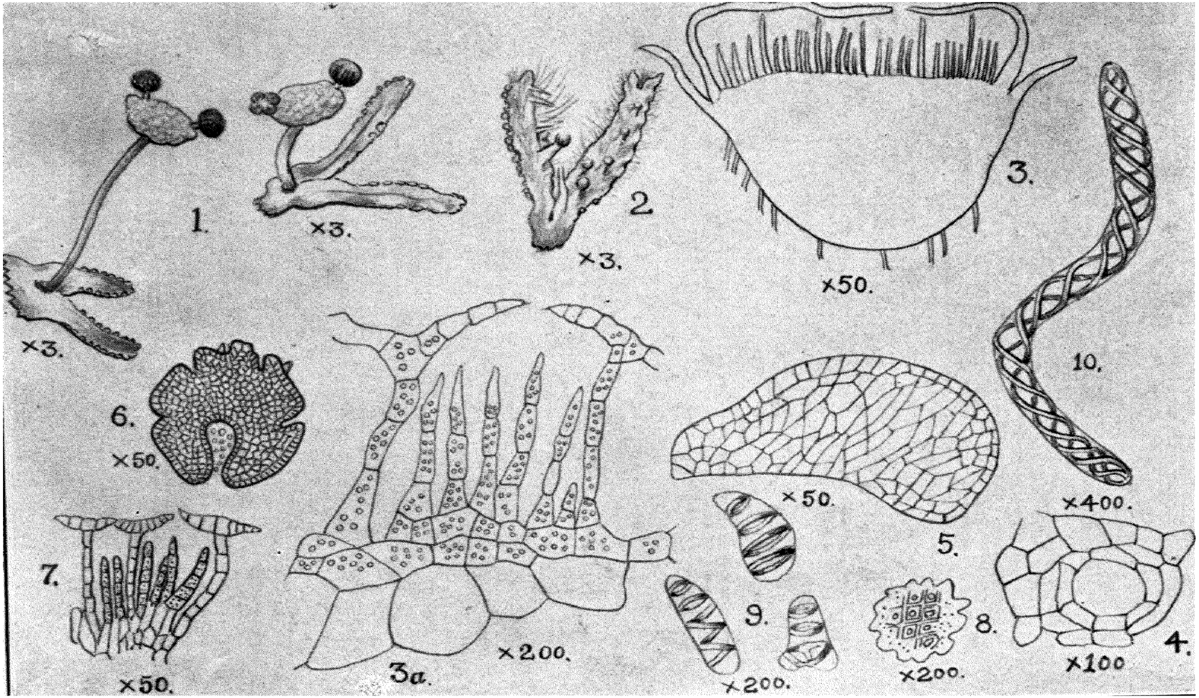

PLATE VII.

PLATE VII.

EXORMOTHECA TUBERIFERA. 1--10.

1. Two fertile female plants.
2. A sterile tuber-bearing plant, from below.
3. T. S. of thallus.
3a. A portion of 3 magnified.
4. A pore from above.
5. A ventral scale.
6. T. S. stalk of the female receptacle
7. Vertical section of female receptacle.
8. A spore.
9. Three elater-like cells.
10. An elater.

IX. EXORMOTHECA Mitt.

Exormotheca Mitt., in Godman Hist. Azores, p. 325 (1870).

Monoecious or dioecious. Plants thallose; thallus simple or dichotomous, lobes linear. Dorsal surface rather flat. Dorsal layer fairly deep. Air-chambers in one layer, full of filaments. stomata raised, simple, often confluent. Midrib strongly produced ventrally. Scales large, densely imbricate, obtuse or acuminate, with or without appendages. Antheridia usually along the mid-dorsal groove. Female receptacle stalked, arising from the apex or the fork between two lobes. Stalk with one deep groove; receptacle convex. Involucres two, opposite, tubular or more or less bivalved, with a broad mouth. Foot large, seta short, capsule spherical, opening by irregular valves; wall one-layered, the cells with annular bands. Lid large, elater-like greatly thickened cells hanging from it. Spores areolate, with areoles smooth or papillate Elaters yellowish. loosely bi-or tri-spiral.

17. **Exormotheca tuberifera** Kashyap.

Exormotheca tuberifera Kashyap, New Phyt. Vol. XIII, p. 309 (1914).
Exormotheca Gollani St., Sp. Hep. Vol. VI, p. 18 (1916).

Monoecious. Thallus twice or thrice dichotomously divided, with long linear lobes firmly attached to the soil; lobes up to 12 mm. long, and usually less than 2 mm. broad. Dorsal surface green, usually with a deep narrow groove and conspicuous, often confluent, stomata. Pores variable in size and in number of cells bounding them, round or elongated, the cells bounding these not differing from those of the epidermis. Filaments simple, terminal cells elongated, tapering upwards, and containing fewer chloroplasts. Midrib strongly projecting ventrally. Ventral surface purple; scales purple, occasionally hyaline, lunate, overlapping, directed outwards and forwards and without any appendage such as is described in other species of the genus. Antheridia often in a depression behind the stalk of the female receptacle or along the midrib in the median groove in a zigzag row; papillae red. Female receptacle arising from a pit in the fork between two lobes, anterior wall of the pit wanting, stalk up to 10 mm. long, with one rhizoid furrow. Receptacle hemispherical, involucres 2, with 1–4 archegonia in each. Air-chambers with green filaments and stomata; pores well-formed, bounded by about 7 cells in one ring. Capsule fully exserted and directed upwards. Seta up to 1·5 mm. long. Cells of capsule wall with semi-annular bands, those of the operculum cells being thicker and broader. Operculum with a few short elater-like cells suspended from it. Dehiscence by 4 irregular valves. Spores tetrahedral, covered with conical papillae on the convex side, 55-60 μ. Elaters 120-140 μ, with 3 or 4 lax spiral bands.

Hab. Comparatively dry slopes.

Distib. Outer Himalayas; Garhwal, *Mussoorie*, about 6,000 feet; S. India, *Madras* (Iyengar).

Note :—The apex of the plant at the end of the season becomes narrow and the dorsal assimilating tissue decreases gradually, producing ultimately a short thick tuber-like structure directed downwards and more or less buried in the soil and protected by scales. This tuber in the next growing season gives rise to another plant. More definite tubers are formed in this species by the modification of the ventral shoots. Each tuber has a short cylindrical stalk and is a spherical body about 0·5 mm. in diameter, covered with rhizoids. The growing point is situated in a small depression surrounded by minute purple scales. The cells of the tuber are full of starch except the epidermal cells which are empty.

The scales have no appendages and the stomata on the female receptacle are well developed. As a matter of fact the bounding cells of these stomata are more definite as regards their number and shape than the stomata on the thallus. Solms-Laubach has stated that there are no stomata on the female receptacle of *Exormotheca pusilla* (Bot. Zeitung, Bd. 55, 1897). Stephani also states that the chambers on the female receptacle do not open to the outside (Sp. Hep. Vol. I, p. 218).

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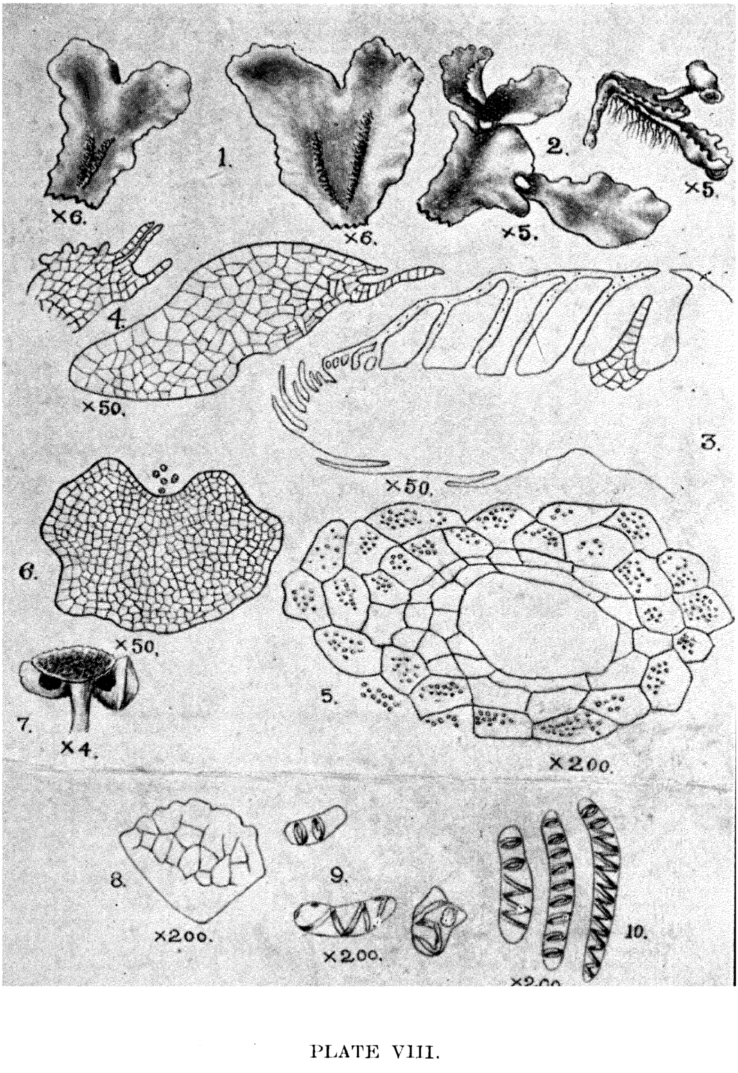

PLATE VIII.

PLATE VIII.

STEPHENSONIELLA BREVIPEDUNCULATA. 1—10.

1. Two male plants.
2. Two female plants, note the continuation of the growth after the formation of the receptacle and the apical tuber.
3. L. S. of thallus.
4. Two ventral scales.
5. A pore from above.
6. T. S. stalk of the female receptacle.
7. Female receptacle.
8. A spore.
9. Three Elater-like cells.
10. Three elaters.

X. STEPHENSONIELLA Kashyap.

Stephensoniella Kashyap, New Phyt. Vol. XIII, p. 312 (1914).

Plants growing singly among moss and grass or aggregated in large patches on rocks. Each plant with a thick base, simple or once or twice dichotomously branched and closely attached to the substratum, light green in colour, spongy above, with a solid midrib strongly projecting ventrally. Upper surface areolated. Chambers large, empty. directed forwards, opening by simple stomata. Ventral surface greenish; scales in 2 rows. Antheridia aggregated in a long and broad mid-dorsal groove in large numbers, close to each other, in 2 or 4 zigzag rows, forming a definite receptacle; papillae red, conspicuous at maturity. Female receptacle at first terminal, later on becoming dorsal by the continued growth of the thallus arising as a small hemispherical cushion in a deep pit, protected while young by scales. Involucres 2, broad, archegonia 1 to 6 in each involucre. Stalk short with a shallow anterior groove containing a few tuberculate rhizoids. Tissue of the receptacle well developed, with empty chambers and definite pores. Involucre tubular, opening by a wide mouth. Sporogonium wholly or partially included, with a small foot and a small seta; dehiscing by 3-4 irregular valves. Capsule wall of a single layer of cells, with thick brown bands on the radial walls only. Spores tetrahedral, large. Elaters short, stumpy, with spiral and annular bands.

18. **Stephensoniella brevipedunculata** Kashyap.

Stephensoniella brevipedunculata Kashyap, New Phyt. Vol. XIII, p. 312(1914).

Dioecious. Thallus up to 12 mm. long and 4 mm. broad, growing from a thick base, margins wavy; simple or forked once or twice; lobes obovate or oblong, apex emarginate. Ventral adventitious shoots common. Dorsal surface areolate; epidermal cells polygonal, walls thin. angles not thickened. Stomata often confluent; each pore surrounded by 1 or 2 rings of hyaline cells the number of which is variable. Ventral surface greenish; scales hyaline, small, in 2 rows, each scale with a few filamentous appendages arising from the apex and the margin. Midrib projecting ventrally and gradually passing into the lamina. Antheridia in a cluster in a mid-dorsal groove, sometimes interrupted by sterile vegetative tissue. Female receptacle stalked at maturity, sessile and protected by scales when young. Stalk short, up to 1·5 mm. long, with a wide shallow groove anteriorly, without scales at maturity. Capsule wall of a single layer of cells, the cells with bands on their radial walls only. Spores tetrahedral, large, opaque, covered densely with low large and small papillae, irregularly toothed or bluntly lobed along the margin, 80-100 μ. Elaters very small, with only annular bands or a single lax spiral band, 80-140 μ long. Short elater-like cells, only annularly or spirally thickened, hanging from the apex of the capsule.

Hab.	On rocks, or among grass and moss.
Distrib.	Common in the Kumaon and the Outer Himalayas. *Mussoorie*, *Simla;* Kulu, *Dulchi pass*; etc., 6,000 to 7,000 ft.

Note:—The growth of the thallus after the formation of the female receptacle may be very slight, resulting only in a small process or a cylindrical tuber, or it may give rise to a large, even branched shoot. The female receptacle, therefore, becomes definitely dorsal. Correlated with this is the fact that the groove in the short stalk of the receptacle is very shallow and contains only a few rhizoids. The rhizoids naturally cannot reach the ground and have no function to perform and they are being eliminated.

At the end of the season each lobe produces at the apex a cylindrical downwardly directed tuber. This is a continuation of the midrib of the lobe, the lamina not having been formed. The tuber remains underground in winter and grows into a new plant next year. This tuber of the apex also explains the fact that the adult plants are thick at the base, having grown from the tubers.

The plant is closely related to *Exormotheca* as shown by the position of the receptacles and its two involucres particularly. It is also clearly a reduced form from a type like *Exormotheca* as seen by the empty chambers, simpler pores, simpler elaters and the shifting of the terminal female receptacle to the dorsal side. Both the Himalayan *Exormotheca* and this species bear tubers. They are often met with growing in the same locality.

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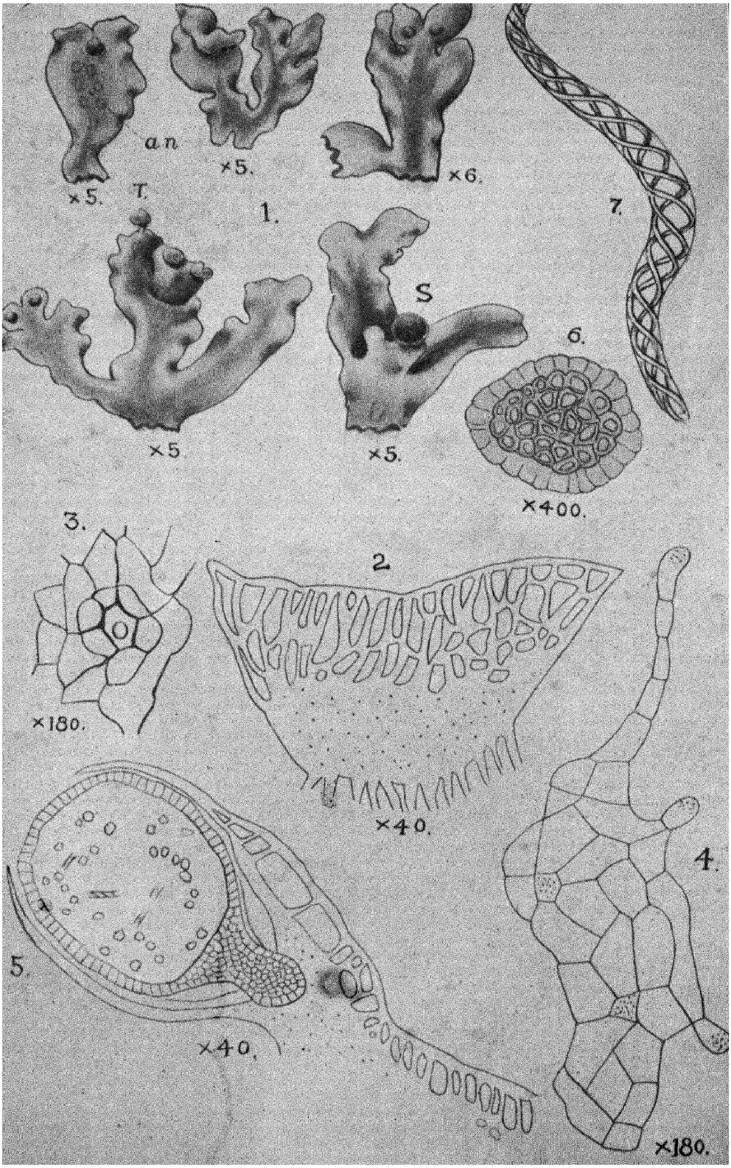

PLATE IX.

PLATE IX.

AITCHISONIELLA HIMALAYENSIS.

1. Five plants showing various forms; an, antheridia; T, tuberous apex; S. sporogonium.
2. T. S. of thallus.
3. A pore in surface view.
4. A ventral scale. Note mucilage cells.
5. L. S. of thallus and sporogonium. Note continuation of the thallus tissue into the involucre.
6. A spore. 7. An elater.

XI. AITCHISONIELLA Kashyap.

Aitchisoniella Kashyap, New Phyt. Vol. XIII, p. 219 (1914).

Monoecious. Singly or in small patches. Thallus small, *Riccia*-like, dichotomously branched, sometimes apparently pinnate. Plants light green, rather grey. Dorsal surface perfectly smooth. Pores simple, not raised. Chambers in one layer or two layers near the margin, oblique, without filaments. Ventral scales in 2 rows with terminal filamentous appendages. Antheridia in 2 rows along the midrib, embedded in the thallus behind the female receptacle, papillae very inconspicuous. Female receptacle terminal, lateral, or in the fork between two branches, subsessile, with 1 or 2 tubular involucres, joined to the thallus by a stalk-like constriction, having a groove on the anterior side. Receptacle tissue continuous with the tissue of the thallus behind. Archegonia 5 or 6 in each involucre. Capsule included, with a well developed foot, and a very short seta, wall one-layered, cells of the wall with annular and spiral bands. Short elater-like cells with annular bands projecting from the base and the apex of the capsule into the cavity. Elaters fusiform.

19. **Aitchisoniella himalayensis** Kashyap.

Aitchisoniella himalayensis Kashyap. New Phyt. Vol. XIII, p. 219 (1914).

Monoecious. Thallus dichotomously divided or occasionally apparently pinnate, lobes 4 mm. long and 2 mm. broad, oblong-ovate, with a notch at the apex. Dorsal surface perfectly smooth; epidermal cells thin-walled. Pores minute, simple, not raised, each surrounded by a ring of 6 cells with slightly thickened radial walls. Air-chambers empty in 1 layer, or in 2 layers near the margin. Ventral surface hyaline or bluish, scales small, distant, hyaline or bluish, triangular or lunate, with mucilage papillae on the margin and the body, not projecting beyond the margin; appendage of 3-5 cells, last cell mucilaginous. Midrib thick, projecting strongly on the ventral side and passing abruptly into the thin lamina. Antheridia on the dorsal side, in 2 rows, behind the female receptacle; papillae very inconspicuous.

Female receptacle variable in position, terminal, lateral, or in the fork between two sterile lobes. Receptacle of 1 or 2 involucres joined to the thallus by a small stalk-like constriction having a distinct groove and a few scales on the anterior side. Each involucre with a single sporogonium; foot well developed, seta a mere constriction. Spores tetrahedral, densely covered with round papillae on the convex side, 36 μ. Elaters simple or branched, tri-spiral, 120 μ long.

Hab.	Comparatively dry slopes.
Distrib.	Fairly common, *Mussoorie*, *Simla*; Kulu, *Dulchi-Pass*.

Note:—A most remarkable plant in having a subsessile female receptacle.

The plant is related to *Targionia* in the structure of the capsule. As regards the position and structure of the receptacle and the involucre it is intermediate between *Exormotheca* and *Targionia.* If the stalk of the receptacle in *Exormotheca* is eliminated we get a receptacle of the type of *Aitchisoniella*, and if the stalk-like portion in the latter genus goes on growing into an ordinary thallus, the condition as seen in *Targionia* is reached. In the position of the female receptacle and the variations as regards the number of involucres in each receptacle the plant shows much resemblance to the male receptacle of *Cyathodium tuberosum*. In the structure of the thallus (air-chambers and pores), the plant resembles *Athalamia.* On account of the above mentioned features this species breaks down the demarcation between the *Compositae* of the *Marchantiaceae* and the *Targioniaceae.* Owing to the transitional character of *Aitchisoniella* the family *Targioniaceae* has been merged into the family *Marchantiaceae.*

In its natural habitat the plant looks very much like a *Riccia*, and can only be found after a careful observation unless it forms a large patch.

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XII. CYATHODIUM Kunze.

Cyathodium Kunze, in Lehm. Pug. VI, p. 17 (1854).

Monoecious or dioecious. Plants thin, small, tufted, on rocks or on ground. Thallus thin, consisting of a dorsal and ventral layer of cells separated by an air-space divided by thin vertical partitions. Dichotomously divided. Air chambers in one layer, empty, with or without simple pores. Pores when present large, bounded by concentric rings of cells. Scales minute, in two rows, or wholly absent. Rhizoids smooth, some thick-walled but not tuberculate. Position of the male receptacle variable; terminal, lateral, or in the fork between two branches. Antheridia numerous, ostioles papillose. Involucre at the apex usually on the undersurface as in *Targionia*, tubular or bi-valved; archegonia a few, in a cluster. Capsule globose, inserted by a small foot. Seta small, slender, delicate. Wall 1-layered, cells of the upper part with annular bands, those of the lower half thin walled, lid definite, of 2 or 3 layers of cells, the outermost layer usually of 4 cells. Capsule dehiscing by 8 equally large valves after separation of lid. Spores spherical, more or less muricate. Elaters fusiform, trispiral.

20. Cyathodium tuberosum Kashyap.

Cyathodium tuberosum Kashyap, New Phyt. Vol. XIII, p. 210 (1914).

Cyathodium penicillatum St., Sp. Hep. Vol. VI, p. 4 (1916).

Dioecious. Sterile plants small, yellowish or green, once or twice dichotomously divided, densely overlapping, the lobes linear to oblong. Male plants more or less branched, lobes linear or oblong-obcordate. Female plants linear or linear oblong, but more often, owing to repeated rapid dichotomy, fanshaped, with ascending margins; the narrow plants less than 2 mm. broad, the large ones 1 cm. long and 2 cm. broad. Dorsal surface usually flat; epidermis with chloroplasts. Pores on the dorsal surface absent in sterile and smaller male and female plants, ventral pores present in many. Dorsal pores found only in well developed female plants, scattered, circular behind the apex, elongated and elliptic further back. Each pore bounded by 2 or 3 series of 4 or 5 cells each. Ventral pores simple, large, bounded by ordinary cells of the thallus, elongated antero-posteriorly. Ventral surface flat. Midrib absent. Rhizoids both thin walled and thick walled, but the latter without pegs. Scales simple cell-rows or small plates, cells with chloroplasts. Male receptacle lateral and cushion-shaped; or in the fork between 2 branches and then circular or elongated laterally; or terminal and then disc-shaped, 4-10 lobed, sub-sessile, with a stalk-like constriction having a shallow groove anteriorly, lobes with scales on the under surface and antheridia on the upper surface in acropetal order. Number of involucres in large female plants very large (up to 20 or more), with 1-4 ripe sporogonia in each. Involucres ovoid, opening by a circular or elliptic mouth, margins often purplish Sporogonium with a foot of two lobed cells, seta of one row of cells. Capsules 0·5-0·75 mm. in diam.; lid 80 μ in diam.; cells of the outermost layer of the lid usually 4; cells of the upper portion of the wall with annular bands; cells of the lower portion thin-walled. Spores spinous, 40 μ in diam. Elaters 17-30 in number, sometimes very few, even only 2 or 3, trumpet-shaped, usually fixed by the broader end to the wall of the capsule along the lines of dehiscence, very closely broadly trispiral, 500-550 μ.

Hab. In moist shady places and dark caves.

Distrib. Outer and Kumaon Himalayas, common up to 8,000 feet; Panjab Plain, *Jullundur* (A. R. Akhtar). *Allahabad* (Dudgeon); *Lucknow* (S. K. Pande); *Benares* (N. K. Tiwari); Mount Abu (V. V. Apte); *Karla Caves, Poona* (S. L. Ghose); *Bombay* (d'Almeida); *Madras* (Iyenger); N. Kanara (Sedgwick); *Rangoon* (S. L. Ghose).

Note :—Towards the end of the season the apical part of the sterile plants and the sterile lobes of the male and female plants becomes thick and compact and marked off from the thallus behind. Each possesses one or two growing points and is beset with spike-like forwardly directed hairs on all sides. These resting structures, "tubers," are formed at the end of the season, remaining dormant during the winter, and growing into new plants at the beginning of next summer. Tubers are formed in the Himalayan plants only, they have not been seen in plants from the plains.

PLATE X.

CYATHODIUM TUBEROSUM

1. Six male plants showing the various forms and positions of the male receptacle.
2. A fan-shaped female plant.
3. Apical "tubers."
4. T. S. of a "tuber."
5. A dorsal pore in surface view.
6. A ventral pore in surface view.
7. Operculum. Three of the four original cells have further divided in one figure.
8. Two ventral scales.
9. A spore.
10. The ends of an elater from a specimen from Mount Abu.
11. The broad fixed end of an elater from a Himalayan specimen.

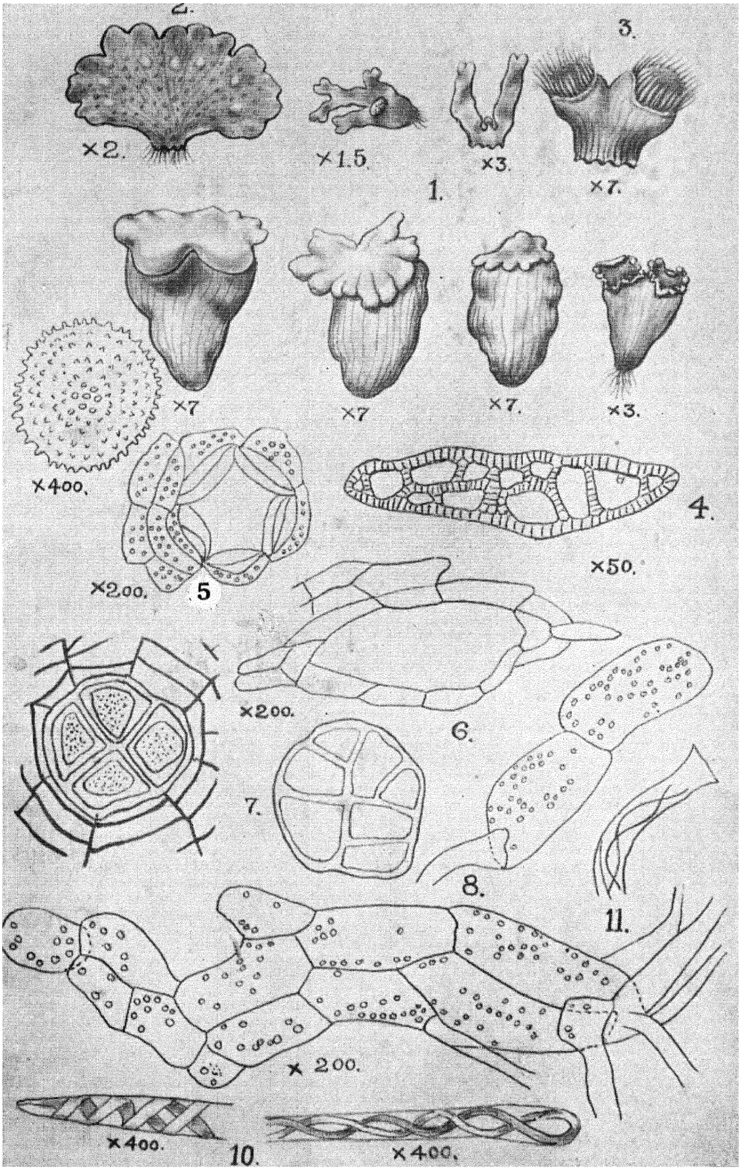

PLATE X.

The plant grows in dark and moist places, and under these conditions it has a yellowish phosphorescence. Plants growing in comparatively open places, under trees, etc., are very much larger. The male plants under these conditions, have many-lobed large terminal receptacles and they are usually hidden under the female plants, while the latter are large, fan-shaped, green, with dorsal stomata.

After fertilisation stiff short hairs, similar to those on the 'tubers' begin to grow from the base, apex and margin of the scales near the involucre, the ventral surface of the involucre, and the margins and sometimes even from the dorsal surface of the thallus for some distance behind the apex.

The air chambers sometimes contain small colonies of some blue green alga or even the eggs of some insects which have no doubt entered through the ventral pores.

The plant is very variable and very likely the species described as *Cyathodium cavernarum* Kunze and *C. aureo-nitens* (Griff) Schiffn. are merely forms of *C. tuberosum*.

The variability is not limited merely to the vegetative parts but extends also to the receptacles, the spores and the elaters.

The thallus may be very yellowish, small with long linear lobes and then occurs in thick patches of overlapping plants, or the plants may be larger, distinctly green, growing singly, fan-shaped with upturned margins, possessing large dorsal pores. The possession of large very much simpler pores on the ventral side of the former type is very interesting The male receptacle is very interesting. It is very variable as stated in the description. Obviously the size of the receptacle is inversely proportional to the vegetative branches. It is very small and without distinct lobes when it is lateral or in the fork between two vegetative lobes. When it is terminal, as for example, in plants occurring hidden under the large female plants, it is large, distinctly lobed, with a short stalk-like constriction which has even a shallow groove anteriorly. The lobes bear antheridia acropetally and possess scales on the under surface. The whole receptacle in these cases is undoubtedly of the type met with in the higher *Marchantiaceae*.

The outermost layer of the lid consists usually of four cells, but sometimes some of the cells are again divided. Griffth has figured such a lid with divided outer cells in *C. aureo-nitens*.

The elaters are always few, though their number varies greatly. They are fixed by their broader end to the capsule wall along the lines of dehiscence, in rows when their number is comparatively large. In the specimens from Mount Abu all the 6 or 7 elaters came out of the capsule on teasing and are apparently free, but even in these specimens one end of the elater is always pointed and the other is blunt and obliquely broad.

The spores always possess spinous projections. In a specimen from N. Kanara sent by the late Mr. Sedgwick their size was rather large, being 54 µ.

See also the note at the end of the next genus, *Targionia.*

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XIII. TARGIONIA L.

Targionia L., Sp. Pl. p. 1136 (1753).

Monoecious or dioecious. Plants thallose, terrestrial, prostrate. Thallus simple, with ventral innovations near the apex, or rarely dichotomously divided, with indistinct areolae on the dorsal surface. Pores simple. Air chambers distinct, full of filaments. Ventral scales in two rows. Antheridia on the dorsal surface of the disc-like ends of short ventral innovations arising from the midrib, or in long and broad mid-dorsal cushions on the main shoots; ostioles papilliform. Involucres 2-valved, on the under side just behind the apex, the 2 valves inter-locked by means of small microscopic teeth on the cells of their margins. Archegonia several, sporogonium usually one in each involucre, rarely 2. Perianth absent. Capsule shortly pedicellate, with a well developed foot, at length breaking through the calyptra, the 2 valves of the involucre separating, leaving a slit-like opening. Apical portion of the capsule becoming detached in one or more fragments at maturity, the remainder being divided into 5-8 irregular valves. Capsule wall of one layer of cells with spiral and annular bands. Spores reticulate. Elaters long, bispiral.

Note:—Although the archegonia are said to be on the under surface and behind the apex, they really are on the morphologically upper surface (only apparently on the under surface). The apical growing point has been pushed downwards and backwards so that the apical cell is situated on the apparently under surface and the archegonia are formed in the usual acropetal order so that the youngest archegonium is just behind the apical cell and the oldest further back, *i. e.*, towards the anterior end of the thallus, near the apical notch. This is true also of *Cyathodium*, though Lang (Annals of Botany, 1905) states that in *Cyathodium cavernarum* the archegonia are actually on the dorsal surface and the ventral shifting of the archegonia does not take place in that species. In the involucre of the other *Marchantiaceae* also the archegonia are found apparently on the under surface for the same reason. In forms like *Plagiochasma* they can be clearly seen to be on the upper surface in the very young receptacle.

21. Targionia hypophylla L.

Targionia hypophylla L. Sp. Pl. p. 1136 (1753).

Monoecious or dioecious. Thallus usually 10-15 mm. long, occasionally 20 mm. long, and 2-4 mm. broad; often with adventitious ventral shoots, and rarely dichotomously divided; apex incised bi-lobed; dorsal surface green; margin entire: areolae indistinct; epidermal cells 5-6-angled, walls slightly thickened and angles much thickened. Dorsal layer shallow, air-chambers distinct, containing green filaments. Filaments of the air chambers anastomosing and reaching the roof, except under the pore. Terminal cells of the filaments under the pore hyaline with very few chloroplasts, in other places chloroplasts numerous in all the cells. Pores simple, conspicuous, slightly elevated, with 4 concentric rings of 6 cells each. Ventral surface purple; scales obliquely broadly triangular, with long subulate apex, margin usually with projecting mucilage cells. Midrib prominent below, rather suddenly passing into the lamina. Antheridia aggregated on the discs of the short ventral shoots, or on the dorsal side of the main shoot forming a long and broad mid-dorsal cushion. Involucre sub-globose, keeled, purple, containing 5 or 6 archegonia but ultimately only one sporognium or occasionally two sporogonia. Capsule spherical, wall of a single layer of cells with annular and spiral bands. Spores 30 to 40 µ. Elaters 140 to 188 µ.

Hab. On moist and dry rocks.

Distrib. Common throughout the region, at altitudes of 5,000—7,000 feet.

Note:—Stephani does not describe it as occurring in India, whereas, Mitten has described it from the N.W. Himalayas under *T. Michelli* Corda, which is given by Stephani as a synonym of the above species.

In moist and shady places the plants form masses of deep green overlapping individuals which are fixed to the soil only at their base. The scales and involucres in such cases are purple. In exposed places the plants are closely creeping, almost always dichotomously divided, light green or yellowish above, with hyaline or light purple scales and involucres. The spores in these cases are smaller, 25 to 30 μ, and elaters longer, 180 to 200 μ.

Antheridia are usually found on the well-known small disc-like ventral shoots with cylindrical stalks. These shoots have a more or less circular margin and are covered on the dorsal surface with antheridial papillae. Occasionally, however, these disc-like shoots develop more or less well-developed wings and in such cases the antheridia form a definite cushion in the middle. The scales on the under surface of these shoots are scattered. Sometimes antheridia are met with in the form of a large definite mid-dorsal cushion on the ordinary lobes of the thallus also. In such cases usually the growing point at the apex divides and the scales on the under-surface just behind the apex appear to be scattered. It appears, therefore, that the short ventral male shoots are merely greatly condensed ordinary shoots with many growing points, the latter having become obscure.

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XIV. CRYPTOMITRIUM Austin.

Cryptomitrium Austin, in Underwood Bull. ILL. St. Labor. II, p. 36 (1884).

Plants thallose, broad, thin, green, closely creeping, attached to the soil by the midrib only. Thallus once or twice divided. Dorsal surface flat. Dorsal layer low; air-chambers large, empty. Stomata slightly raised, simple. Midrib narrow, passing into the thin broad wings. Scales small, distant, in two rows. Antheridia in the mid-dorsal groove, 2- or 3-seriate, papillae very small. Female receptacle terminal, stalked; stalk long, naked, with one or two furrows, and a few ridges. Receptacle thin, broad, circular, with an irregular

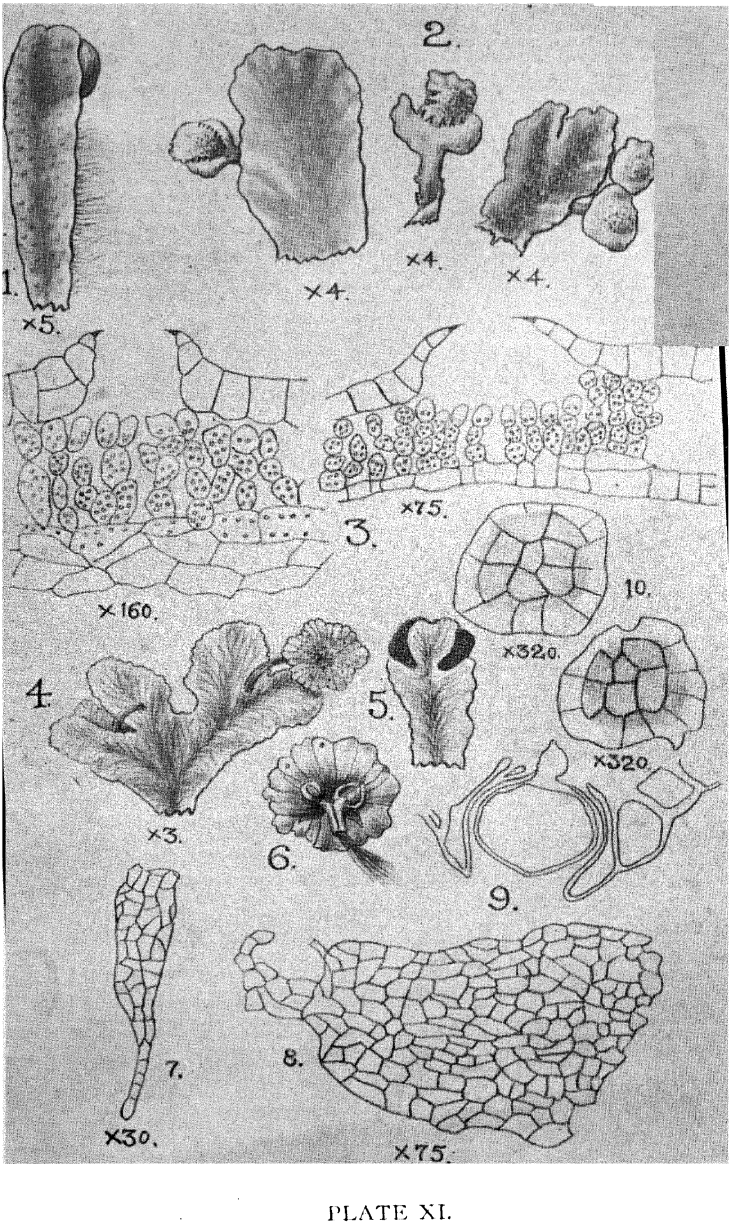

PLATE XI.

PLATE XI.

TARGIONIA HYPOPHYLLA. 1—3.

1. A female plant from above.
2. Three specimens showing male ventral shoots. Note the male cushions on the main shoot also in the right hand specimen.
3. T. S. thallus showing variations in the pore structure.

CRYPTOMITRIUM HIMALAYENSE. 4—10.

4. A fertile plant.
5. The tuberous apex from above.
6. Female receptacle from below.
7. Ventral scale from the ordinary thallus.
8. Scale from the tuberous apex.
9. Vertical section of involucre with sporogonium.
10. Two spores.

margin, convex on the dorsal side, flat ventrally, stomata barrel-shaped. Involucres wholly on the under side, not reaching the margin, up to six in each receptacle; archegonia 3-4 in each. Perianth absent. Sporogonia not exserted. Foot spherical, seta small. Capsule included, lid definite, 2-layered, cells of the capsule wall without bands. Spores brown, tetrahedral, reticulate. Elaters sinuous, often branched, bi- or tri-spiral.

22. **Cryptomitrium himalayense** Kashyap.

Cryptomitrium himalayense Kashyap, New Phyt. Vol. XIV, p. 2 (1915).

Monoecious. Thallus yellowish or green, very delicate, once or twice forked, lobes quadrate, up to 6 mm. long and about 6 mm. broad, apex cordate, margin irregularly bluntly crenate. Dorsal surface areolated; epidermal cells thin-walled. Pores small, slightly raised, not in all areoles, bounded by 3 rings of 8 cells each. Ventral surface brownish; scales minute, hyaline or greenish, purplish and much larger under the tuberous apex, ovate, distant, in 2 rows, margin of the scale occasionally toothed, apex with a filament of 5 or 6 cells, cells of the scale contain chloroplasts. Antheridia in a mid-dorsal groove, just behind the stalk of the female receptacle or on the adjacent lobe. Female receptacle usually on one lobe of the fork. Stalk with one deep groove, up to 3 mm. long, and with 6 to 8 ridges. Receptacle thin, broad, circular, with irregularly toothed margin, slightly convex on the dorsal side in the centre, flat on the ventral side, margin often curved upwards. Involucres 2-4, most often 3, not reaching the margin. Opening long, narrow; archegonia 2 in each. Sporogonia 1 to 3, foot and seta small, capsule wholly included. Operculum 60 μ in diam.; cells of the capsule wall 50 to 80 μ × 20 μ. Spores brown, 55 to 60 μ, tetrahedral, broadly reticulate-lamellate on the convex side, border light brown, reticulations 2 or 3 in diam. (excluding the border). Elaters 350-400 μ long, closely trispiral.

Hab. Moist and often dark places.

Distrib. *Mussoorie*, *Simla*, 6,000—7,000 feet.

Note:—The plant grows in moist places under the dense shade of trees or in caves, often along with *Cyathodium tuberosum*. Like the latter it has a yellowish colour.

Stephani (Sp. Hep. Vol. I, p. 222) states that in *C. tenerum*, the only other species of the genus, the stalk of the female receptacle may have one or two furrows. The Himalayan species has always only a single furrow. It is of interest to note in this connection that a plant from Mussoorie showed two perfectly normal receptacles at the top of a stalk arising from the apex of an ordinary lobe and even this stalk had only a single furrow. Compare the branched stalk of the female receptacle in *Marchantia palmata* described under that species.

At the end of the season the apical portion of the lobes becomes thickened and marked off by a crescentic purple band behind. The more or less circular terminal portion becomes changed into a crumpled knot on drying and remains in this condition during the winter. The rest of the thallus dies away. Next summer the twisted persistent portion spreads out and begins to grow.

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The following plant, *Massalongoa tenera*, has been described by Stephani, but has not been seen by me.

XV. MASSALONGOA St.

23. Massalongoa tenera St.

Massalongoa tenera St., Sp. Hep. Vol. VI, p. 65 (1917).
Massalongoa tenera Hedwigia, Vol. XLIV, p. 74 (1905).

Thallose, large, delicate, green, terrestrial, prostrate, clustered. Fronds simple, thin, apex briefly inciso-bilobed, innovating from the apex; dorsal surface subplane. Dorsal layer well developed, chambers in three series, wide, margins crenulate. Midrib broad, low. Pores compound, inner opening bounded by eight conical converging cells. Ventral scales large, narrowly triangular, apex with a long setaceous appendage. Dioecious. Female receptacle shortly and strongly peduncled, stalk with a deep groove, receptacle large, disc-shaped, margin coarsely crenate. Involucres four, cruciate, cup-shaped, and half covering the ripe capsule; calyptra delicate, partly united to the involucre. Capsule thin, wall one-layered, brown, lid large, regularly dehiscing. Spores large, 74 μ, laxly reticulate. Elaters 470 μ, tri-spiral, long attenuated, strongly twisted. Male receptacle not seen.

Hab. Sikkim Himalaya (Gollan); *Mussoorie* (Gollan).

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XVI. FIMBRIARIA Nees.

Fimbriaria Nees, in Hor. phys. Berol., p. 45, (1820).

Monoecious or dioecious. Plants thallose, terrestrial, prostrate, small or medium, green. Thallus simple, rarely divided, innovating from the apex and o~~ften with~~ ventral (fertile) innovations. Dorsal layer low, chambers narrow, often very irregular, and with numerous secondary lamellae, in one or several layers, empty or containing filaments. Stomata simple, slightly convex, rarely highly conical. Ventral scales with appendages, in one row on each side of the midrib. Male receptacle sessile, naked, disc-shaped, or cushion-like, just behind the stalk of the female receptacle, on ordinary main shoots, or on small ventral shoots; papillae small. Female receptacle terminal, on the main shoot, or on small ventral shoots, stalked; stalk with one rhizoid furrow covered with scales; receptacle flat, convex, conical, or umbonate, usually 4-lobed; stomata barrel-shaped. Involucres arising from the margin of the lobes, thin, cup-shaped or campanulate. Archegonium one in each involucre. Perianth usually ovate or oblong with an obconic apex, dividing longitudinally by many teeth. Sporogonium one in each involucre. Capsule globose, shortly pedicelled, wall one-layered, lid of thick-walled cells. Spores tetrahedral, reticulate-lamellate on the convex side, more or less yellow. Elaters short, simple or furcate, mono- or bi-spiral.

Note.—It is curious that all the five species of the genus described here from my own observations differ from each other in the position of the male and female receptacles. The position of the receptacles in itself could hardly always be a distinctive specific character, though it is quite constant in these species. It so happens, however, that in each of these species this character is also associated with other specific characters. In fertile plants it is, therefore, very easy to distinguish the species by an examination of the position of the receptacles.

Key to the Species.

Of the twelve species described here only five, have been collected by the writer. The remaining seven have been included as they have been described by Stephani in "Species Hepaticarum" ccurring in the Himalayas. Only the first five species are in-ed in this key.

Plants dioecious.. *F. angusta*
Plants monoecious.. 2
Male receptacles on the main thallus.. 3
Male receptacles on short ventral shoots arranged laterally 4
Female receptacles terminal on the main shoot in front of male receptacle.. *F. Blumeana*
Female receptacles on short ventral shoots, male on the main shoot.. *F. pathankotensis.*
Female receptacles terminal on the main thallus. *F. reticulata*
Female receptacles also on small ventral shoots *F. mussuriensis*

24. Fimbriaria Blumeana Nees.

briaria Blumeana Nees, Syn. Hept. p. 564 (1844).

Monoecious. Thallus about 7 mm., sometimes 10 mm., long 3 mm. broad, linear, simple, or once or twice dichotomously ıched, apex notched, lobes obcordate, margin entire. Dorsal ermal cells polygonal, walls thick, trigones not very large. sal layer rather shallow. Pores large, bounded by two series cells each. Air-chambers large, empty. Midrib not very con-uous ventrally. Ventral surface usually green; scales few, ınt, purple, appendage lanceolate, acute or long acuminate, re, occasionally with a few projecting cells on the margins. e receptacle cushion-like, behind the stalk of the female ptacle. Female receptacles stalked; [illegible] mm. long, ɔle, thin at the top, top paleaceous [illegible] ong, linear. eptacle convex, usually 3-lobed, perianth hyaline, oblong, exserted. Spores golden yellow, wing crenate, 72 μ in diam. ers bispiral, 260 μ long.

Hab. On rocks.

Distrib. *Mussoorie*, *Simla*, etc. 5,000—7,000 feet.

Note.—Peisal (Botanisches Archiv Vol. X, p. 434), figures etative shoots coming off from the stalk of the receptacle as as the receptacle itself. The same thing is sometimes seen *Marchantia palmata.*

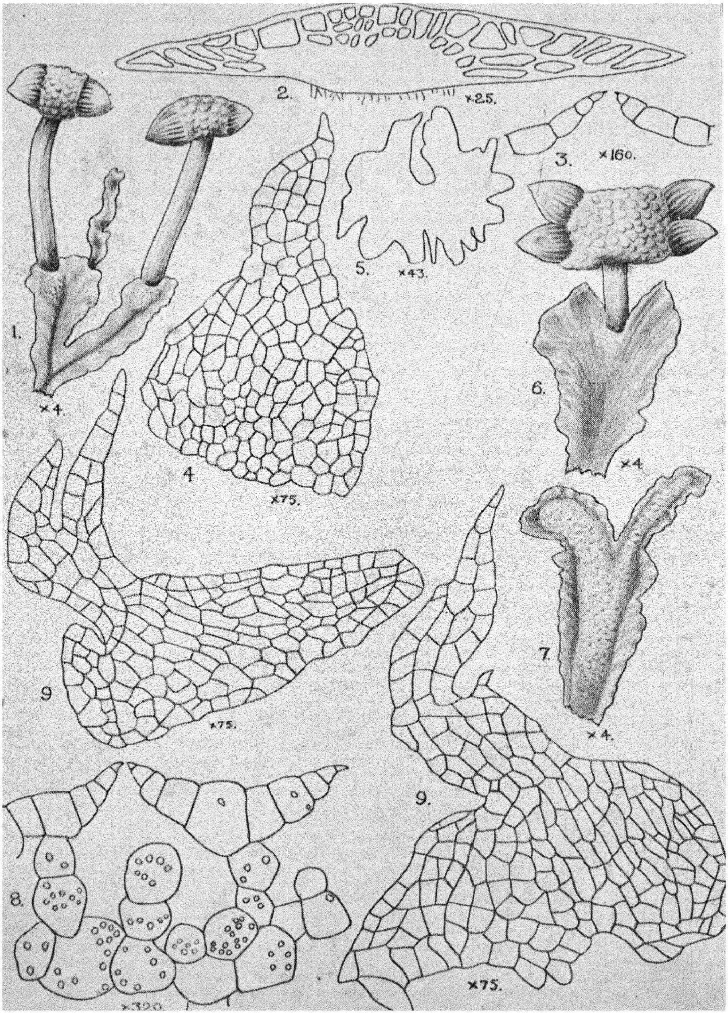

PLATE XII.

PLATE XII.

FIMBRIARIA BLUMEANA. 1—5.

1. A fertile plant. Note the male receptacles behind the stalk of the female receptacle.
2. T. S. of thallus.
3. Vertical section through a pore.
4. A ventral scale.
5. T. S. of stalk of female receptacle.

FIMBRIARIA ANGUSTA. 6—9.

6. A female plant.
7. A male plant.
8. Vertical section through a pore.
9. Ventral scales.

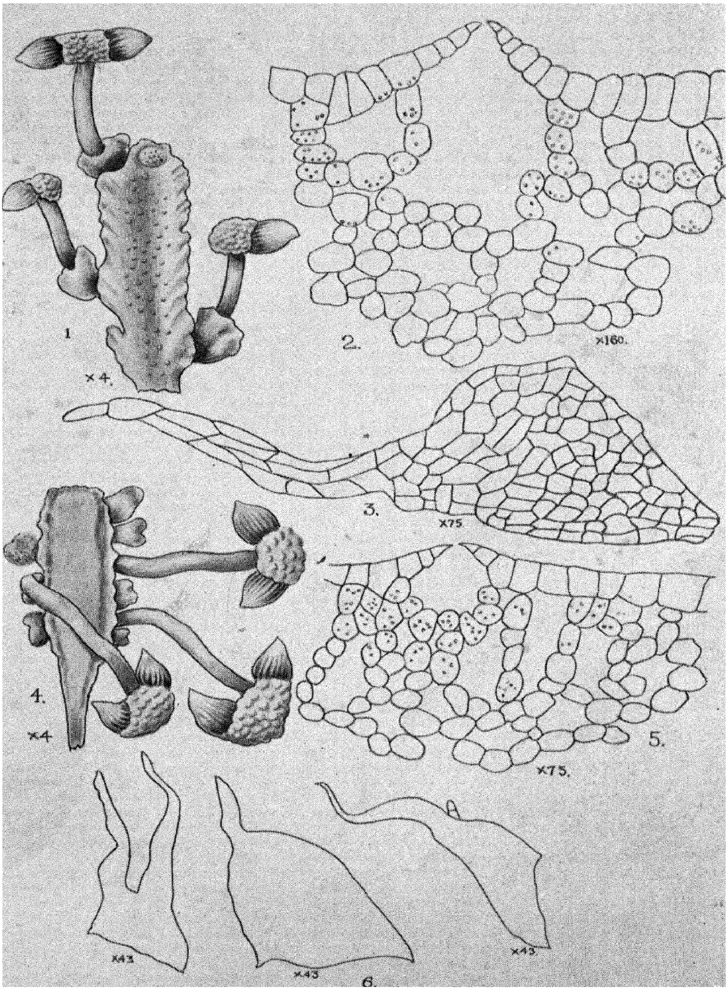

PLATE XIII.

PLATE XIII.

FIMBRIARIA PATHANKOTENSIS. 1—3.

1. A fertile plant. Male receptacle just behind the apex of the main shoot; female receptacles on short ventral shoots.
2. Vertical section through a pore.
3. A ventral scale.

FIMRIARIA MUSSURIENSIS. 4—6.

4. A plant. Mixed male and female ventral shoots.
5. Vertical section through a pore.
6. Three ventral scales.

25. Fimbriaria angusta St.

Fimbriaria angusta St., Sp. Hep. Vol. I, p. 104 (1899).

Dioecious. Thallus up to 20 mm. long and 3 mm. broad; linear or linear-oblong, with apical innovations; dorsal surface flat or slightly canaliculate, margins wavy, often purple, apex notched. Epidermal cells 5-6-angled, walls and angles thickened. Pores large, bounded by 3 series of 6 cells each. Air-chambers usually in one layer above the midrib, with a few free filaments; in more layers in the wings and empty. Midrib, strongly convex, gradually passing into the wings, older parts mycorrhizal. Ventral surface purple, scales purplish, triangular, lunate, with a long lanceolate acuminate appendage, latter often unequally divided at the apex. Antheridia on the main shoot forming a long cushion. Female receptacle disciform, usually with 4 or 5, often only 2, lobes, stalked, stalk 2 mm. long, paleaceous at the top, scales purple, linear. Perianth horizontal, sometimes directed upwards, ovate, 2/3 exserted. Spores tetrahedral, dark brown, closely reticulate, reticulations often imperfect; margin papillate, papillae rounded or conical; 63 µ in diam. Elaters monospiral, yellowish, 162 µ long.

Hab. Generally on dry rocks.

Distrib. Common in the Himalayas, 4,000—7,000 feet. A very xerophytic species, forms large patches on dry rocks. *Mussoorie*, *Simla*, etc.

26. Fimbriaria pathankotensis Kashyap.

Fimbriaria pathankotensis Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 344 (1916).

Monoecious. Closely creeping, in dense green patches. Thallus once or twice forked, up to 2 cm. long, lobes linear or linear-oblong, up to 8 mm. long and 2 mm. broad. Dorsal surface green, flat or slightly convex; margin wavy, purple. Areolae small, indistinct; epidermal cells 5-6-angled, walls thin, angles not thickened. Dorsal layer not very deep. Stomata small, bounded by 2 series of 5 cells each. Air-chambers small, many layered, empty. Midrib convex, gradually passing into the lamina. Ventral surface purple; scales overlapping, purple, exceeding the margins, appendage long, linear, entire. Male receptacle cushion-like, just behind the apex on the main thallus, antheridial papillae small, purple. Female receptacles on very small ventral shoots. Stalk up to 5 mm. long and about 1 mm. thick, paleaceous at the top. Receptacle flat with high stomata and 1 or 2 involucres. Perianth hyaline or reddish, ovate, 2/3 exserted. Capsule one in each involucre. Spores brown, opaque, broadly reticulate, wing finely punctate, 90 μ in diam. Elaters monospiral or partly bispiral, brown, up to 175 μ long, generally less, sometimes branched.

Hab. Banks of ponds, and other moist places.

Distrib. *Pathankot, Lahore, Dehra Dun.*

Note :—A species of the plains occurring chiefly near the foot of the hills about 2,000 feet above sea level. Not common.

27. **Fimbriaria mussuriensis** Kashyap.

Fimbriaria mussuriensis Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 345 (1916).

Monoecious. Thallus green, closely creeping, unbranched, long, narrow, linear-oblong, with ventral and occasionally apical innovations, up to 10 mm. long and 2 mm. broad. Apex round; margin entire. Epidermal cells 5-6-angled, walls and angles thickened. Dorsal layer shallow. Stomata small, bounded by 2 or 3 series of 6 cells each. Air-chambers small, empty, in several layers. Ventral surface greenish or reddish; scales hyaline or reddish, appendages 1 or 2, reddish, linear, entire. Midrib flat, gradually passing into the wings. Antheridia in a hemispherical cushion on small ventral shoots, papillae small. Female receptacles also on small ventral shoots arranged irregularly with the male shoots. Stalk of the female receptacle 10 mm. long, sparsely paleaceous at the base and the whole length, but densely so at the top; paleae purple, long, linear. Receptacle flat or slightly convex, 2-4-lobed, stomata high; perianth conical, lanceolate, 2/3 exserted. Spores opaque, margin entire, 100 μ in diam. Elaters bispiral, up to 200 μ long, occasionally branched.

Hab. Moist shady places.

Distrib. *Mussoorie*, 5,000 to 7,000 ft.; *Lahore* (rare); probably common in the outer Himalayas.

Note:—The small male and female ventral shoots irregularly mixed, or alternating, or male on one side and female on the other side of the plant, are a characteristic feature of this plant. The apex of the plant bends down into the soil at the end of the season and grows up again next year producing a characteristic bend.

In a specimen from Mussoorie the stalk was divided into two parts. The lower undivided portion was 2 mm. in length, while each of the branches was 4 mm. Each branch bore a perfectly normal receptacle at the top.

28. **Fimbriaria reticulata** Kashyap.

Fimbriaria reticulata Kashyap, Jour. Bom. Nat. Hist. Soc Vol. XXV, p. 279 (1917).

Monoecious. Thallus yellowish green or slightly purplish, thin, once or twice dichotomous, up to 6 mm. long and 4 mm. broad, lobes obovate to obovate-oblong, with apical and ventral shoots; dorsal surface flat; margin entire, purplish. Areolae not prominent; epidermal cells 5-6-angled. Stomata bounded by a ring of 6 or 7 cells. Air-chambers fairly wide, in several layers, empty. Ventral surface greenish; scales purple, ovate, overlapping, reaching the margins, appendage ovate to ovate-lanceolate, acute, entire. Midrib broad, sligtly projecting ventrally, rather suddenly passing into the lamina. Antheridia cushion-like, on very short lateral branches arising on both sides of the midrib. Female receptacle terminal on main shoot, stalk naked, reddish at the base, up to 5 mm. long. Receptacle flat or slightly convex, stomata only slightly raised. Involucres up to 4, perianth hyaline, 2/3 exserted. Spores 50-64 µ in diam., brown, reticulate-lamellate, reticulations obscure, 2-3 in the diam. (excluding the wing), wing narrow, finely punctate. Elaters dark brown, more or less loosely bispiral, 200-250 µ.

Hab. Shady places along the road, 8,000 to 10,000 feet.

Distrib. Kashmir; Lahul, *Kyelang*.

Note:—The apical part of the thallus in sterile plants becomes narrowed and thickened and apparently persists in this condition throughout the dry period.

The following species of the genus have been described by Stephani but have not been seen by me.

29. Fimbriaria maculata St.

Fimbriaria maculata St., Sp. Hep. Vol. I, p. 104 (1899).

Monoecious. Green above, hyaline below, large. Thallus up to 20 mm. long and 3 mm. broad, linear, with apical innovations, dorsal surface plane, ventral surface slightly convex, stomata large, bounded by 5 series of 8-9 cells each. Epidermal cells very thick, the walls trabeculate, and trigones large, almost nodular. Dorsal layer in the middle of the frond as high as the midrib; chambers narrow, with filaments. Midrib 1/3 of the breadth of the frond, ventrally broadly keeled. Scales oblique, lower half purple, upper half hyaline, appendage as long as the body of the scale, lanceolate, with a single spine above the base, apex setaceous. Male receptacles on short ventral branches. Female receptacle stalked, stalk short (5 mm.), thick, straw-like, subterete, covered all over with long hyaline scales. Receptacle small, disc-like, slightly convex. Lobes as long as the central disc, not at all free, highly papillate, emarginate. Perianth ovate-oblong, acuminate, mouth shortly beaked, tubular. Capsule light brown, lid with thick trigones. Spores 70 μ, dark brown, wing narrow, crenato-lobate. Elaters 144 μ, thick, rigid, equally broad, reddish brown, monospiral.

Hab. Himalaya, *Sansidara* 5,000 feet (Duthie).

30. Fimbriaria nepalensis Taylor.

Fimbriaria nepalensis Taylor Linn. Soc. 1837, XVII, p. 387.

Monoecious. Small, yellowish green, delicate, margin purple. Fronds up to 7 mm. long and 2 mm. broad, innovating from the apex and the midrib. Dorsal surface flat, ventral broadly convex. Dorsal epidermal cells with thick trigones. Dorsal layer in the middle as high as the midrib, chambers large, with short free filaments. Stomata large, slightly convex, bounded by 5 series of 8 cells each. Midrib broad, plano-convex ventrally, about half the breadth of the frond. Scales small, pink, caducous, appendage lanceolate or ligulate, apex unequally shortly bifid.

Male receptacle near the stalk of the female receptacle, sometimes occupying the whole thallus, highly inflated in the middle, ostioles small, hyaline. Female receptacle stalked; stalk 3-4 mm. long, covered with long hairs at the top, everywhere else with hyaline narrowly lanceolate spreading scales. Receptacle plano-convex, centre small, highly papillose. Lobes sub-horizontal, spreading, inflated, as large as the central disc, mouth slightly decurved. Perianth ovate, apex narrow, distinctly beaked, hyaline and obliquely spreading. Capsule yellowish. Spores 72 µ red, wing narrow, slightly rough. Elaters yellowish, 170 µ bispiral.

Hab. Nepal, (Wallich); N. W. Himalaya, (Gollan, Gamble).

31. **Fimbriaria parvipora** St.

Fimbriaria parvipora St., Sp. Hep. Vol. I, p. 116 (1899).

Monoecious. Small, dark green, up to 7 mm. long and 2 mm. broad, simple or innovating at the apex, dorsal surface strongly canaliculate. Epidermal cells thin. Dorsal layer in the middle of the thallus narrow; chambers low, with very few lamellae, without free filaments, almost empty. Stomata small, not prominent, bounded by 6 cells. Ventral surface blackish. Midrib plano-convex, rather broad, half the breadth of the frond, wing strongly attenuated. Scales small, deep purple, with a large appendage, appendage acuminate from a broad base, and very slightly or not at all constricted at the base. Male receptacle small, in the groove of the thallus; ostioles hyaline, short. Stalk of the female receptacle 10 mm. long, apex with a few purple, triangular scales. Receptacle hemispherical, papillate with small stomata. Lobes as long as the central disc, apex decurved, crenato-lobulate. Perianth oblong, ovate, 2/3 exserted. Capsule? Spores yellowish, 70 µ, wing repando-lobulate, narrow. Elaters yellowish, 360 µ, bispiral, attenuated, spirals in the middle compact, those at the apex loose.

Hab. Kashmir, Lidar Valley 13,000 feet (Duthie).

32. **Fimbriaria sanguinea** L. et L.

Fimbriaria sanguinea L. et L. in Lehm. Pug. pl. IV, p. 5. n. 3.

Monoecious. Plants small, up to 15 mm. long and 3 mm.

broad; linear, innovating at the apex, (female branches very small, from the sides of the midrib); dorsal surface almost flat, green. Dorsal layer above the midrib low, with narrow chambers, filaments reduced to conico-papillate cells. Midrib slightly convex, 1/4 of the breadth of the frond, wings loosely chambered. Stomata large, strongly convex, bounded by 5 series of 6 cells each. Epidermal cells thin-walled. Ventral surface blackish red; scales lunate, long appendaged, appendages 2, side by side, linear, apex subulate, large-celled. Male receptacle always on the dorsal side of the main thallus, disc-like, ostioles purple, numerous. Female receptacle stalked; stalk short, up to 5 mm., straw-coloured, perfectly terete, everywhere covered with linear hyaline scales and especially so at the apex. Receptacle small, hemispherical, lobes equal to the central disc, decurved. Involucres as long as the lobes. Perianth oblong, 2/3 exserted. Rest not seen.

Hab. Nepal, (Wallich); *Simla*, (Griffith).

Note :—Very near *F. pathankotensis* described above.

33. **Fimbriaria multiflora** St.

Fimbriaria multiflora St., Sp. Hep. Vol. I, p. 124 (1899).

Monoecious. Plants green, robust, of medium size. Thallus up to 10 mm. long and 2 mm. broad, innovating at the apex. Dorsal surface green, slightly concave, ventral surface convex. Epidermal cells delicate. Dorsal layer in the middle of the thallus equal to the midrib; chambers large, filled with numerous filaments. Stomata large, slightly convex, bounded by 5 series of 8 cells each. Ventral scales small, with long appendages; appendages narrow, lanceolate, two cells broad, apex setaceous. Male receptacle at the apex of the thallus, circular. Female receptacles on ventral branches aggregated towards the apex of the thallus; stalked, stalk up to 10 mm. long, sub-terete and slightly angled; everywhere covered with filiform hyaline scales. Receptacle plano-convex, centre slightly papillate, deeply 4-lobed; lobes spreading in an umbellate manner. Perianth 2/3 exserted, ovate, obtuse, apex often purple. Capsule yellow, delicate, lid large, strongly thickened. Spores yellow, 54 µ, margin narrow, entire. Elaters 170 µ, yellowish, monospiral, spiral thread-like.

Hab. N. W. Himalaya, (Duthie, Gamble).

34. **Fimbriaria Gollani** St.

Fimbriaria Gollani St., Sp. Hep. Vol. VI, p. 17 (1917).

Dioecious. Plants small, deep green, robust, gregariously growing on moist rocks. Thallus up to 15 mm. long and 5 mm. broad, oblong, simple rarely furcate, 1·5 mm. thick in the middle, dorsal surface canaliculate, wing strong. Midrib strong (2·5 mm. broad and 0·75 mm. thick). Ventral scales large, appendage solitary, lanceolate, as long as the body, attenuate, acute. Androecia in the middle of the frond, ostioles inconspicuous. Female receptacle disciform, concave, central disc small umbonate. Involucres 4, broadly obconic, half free, margin repand or lobulate. Perianth large, as long as the involucre, obovate, pale. Spores dark-brown, 45 μ, margin asperous. Elaters rigid, worm-like, 180 μ, spirals in pairs, loosely twisted.

Hab. Himalaya (Gollan).

35. **Fimbriaria papulosa** St.

Fimbriaria papulosa St., Sp. Hep. Vol. VI, p. 16 (1917).

Monoecious. Plants yellowish, delicate, terrestrial, up to 7 mm. long, plane, simple, oblong (2 mm. broad and 0·37 mm. thick), wings very thin, membranous. Midrib strong (1·5 mm broad, 0·3 mm. thick). Ventral scales destroyed. Androecia at the base of the stalk of the female receptacle, chambers large, numerous. Stalk of the female receptacle 7 mm. long. Receptacle disciform, slightly concave, central disc rather prominent. Involucres 4, somewhat decurved, margin repand. Perianth as long as the disc, ovate, pale. Spores reddish-brown, asperous, wing broad, expanded, 72 μ. Elaters 200 μ., rigid, bispiral, spirals laxly twisted.

Hab. Himalaya, *Mussoorie* (Gollan).

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XVII. GRIMALDIA Raddi.

Grimaldia Raddi, Opusc. sc. Bol. II, p. 356 (1818).

Monoecious or dioecious. Plants thallose. Thallus furcate, with ventral or apical innovations, lobes linear. Dorsal layer with well developed air-chambers, the latter opening by simple stomata, filled with free, erect filaments, often subdivided. Stomata strongly convex. Midrib thick, produced ventrally; scales large, in 2 rows, each with 1 or 2 lanceolate appendages. Antheridia scattered or clustered without any scales, ostioles projecting, purple. Female receptacles terminal on short ventral shoots. Stalk of the female receptacle long, with one deep rhizoid furrow, base paleaceous. Receptacle small, convex, papillose with barrel-shaped pores, shortly 4-lobed. Involucres under the lobes, mostly 4, from the margin of the receptacles, directed downwards obliquely, each with one archegonium, opening by a circular mouth at maturity. Perianth none. Capsule spherical, shortly pedicellate, with a large foot, opening by a definite lid and a distinct annulus. Calyptra thin. Spores large, laxly reticulate, areoles inflated. Elaters short, fusiform, trispiral.

36. Grimaldia indica St.

Grimaldia indica St., Sp. Hep. Vol. VI, p. 10 (1917).

Monoecious. Thallus about 12 mm. long and 2 mm. broad, linear, often simple; dorsal surface flat or slightly concave; margins thin, entire, usually purple. Areolae indistinct; dorsal epidermal cells 5-6-angled, walls thick, trigones small. Dorsal layer shallow, densely chlorophyllous, chambers empty near the margins. Pores simple, bounded by 3 series of 7-9 cells each. Ventral surface purple; scales purple, overlapping, not exceeding the margin, lunate, entire; appendage rarely hyaline, linear-lanceolate, curved, entire, one or two, sometimes 3, appendages to each scale. Antheridia in a mid-dorsal elliptical to linear-oblong red cushion, not sharply marked off from the thallus; papillae purple, conspicuous. Female receptacles always on very small ventral shoots, 4 or 5 of which may be formed on each side of the main frond. Stalk up to 3 cm. long, slender, naked. Receptacle

PLATE XIV.

FIMBRIARIA RETICULATA. 1—3.

1. A plant. Female receptacles at the apex of the main shoots; male receptacles on short ventral shoots.
2. Vertical section through a pore.
3. Two ventral scales.

GRIMALDIA INDICA. 4—6.

4. A plant.
5. Vertical section through a pore.
6. Two ventral scales. Note mucilage hairs.

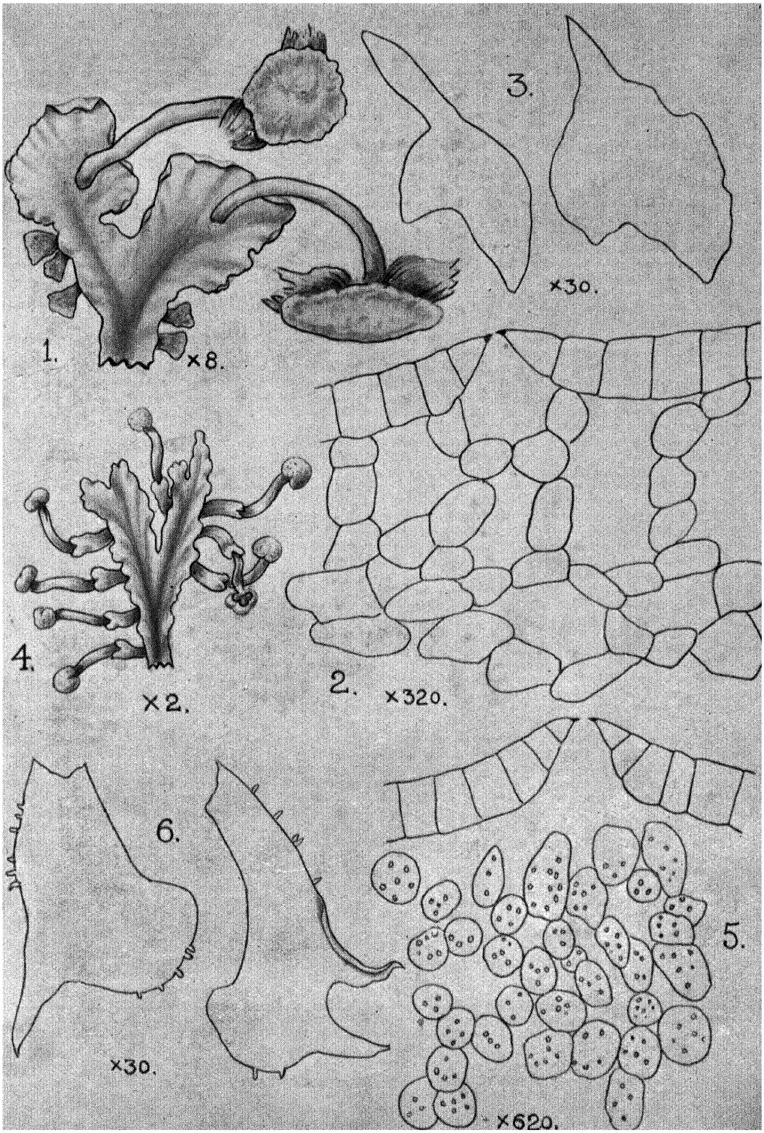

PLATE XIV.

convex; involucres up to 4; capsule slightly exserted; operculum large, brown, 1 mm. in diam., basal cells of the wall 65 × 25 μ, annulus cells 30 × 30 μ, operculum cells 35 × 45 μ. Spores brown, spherical, with large rounded papillæ appearing as lobes on the margin, 60-69 μ in diam. Elaters closely trispiral 190-290 μ.

Hab. On moist as well as dry rocks and soil.

Distrib. Common in the W. Himalayas. A very xerophilous form. In dry places often the only Liverwort. A very widely distributed species throughout the Western Himalayas extending from the plains and the foot of the hills right up to the main range up to an altitude of 10,000 feet. *Lahore*, *Amritsar*, *Pathankot*; *Dalhousie*; Kulu; Pangi; Lahul, *Kyelang*; *Mussoorie*, etc.

Note.—Stephani (Sp. Hep. Vol. I, p. 90) and Mitten (Hep. Ind. Orient. Trans. Linn. Soc. Vol. V, p. 126) have described *G. dichotoma* Raddi also from the Himalayas. The spores and elaters of the plants described above vary a good deal. Several specimens were examined from nine different localities, and several capsules from each locality. The spores varied from 60 μ to 69 μ, and elaters from 190 to 290 μ. In some specimens from Mussoorie the spores were unusually large and measured 90 μ? while the elaters were 250 μ. Similarly the basal cells of the capsule wall measured 20-30 μ × 58-79 μ, and the operculum cells 30-50 μ × 43-60 μ. I can not distinguish *G. dichotoma* from *G. indica* by any character.

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XVIII. REBOULIA Raddi.

Reboulia Raddi, Opusc. Scient. di Bologna II, p. 357 (1818).

Monoecious or dioecious. Thallus dichotomously branched and innovating at the apex, coriaceous, without distinct areolae on the dorsal surface. Pores simple, air chambers empty, in several layers as in *Plagiochasma*. Ventral scales in two rows. Male receptacle sessile, cushion-like, at the apex of a lobe, oval to semicircular, surrounded by small scales. Female receptacle terminal on ordinary lobes, stalked. Stalk surrounded at the base and apex by narrow scales, with a single rhizoid furrow. Receptacle conical or hemispherical, divided to the middle into 4-9 obtuse lobes, with air spaces and compound pores; involucres arising on the underside of the lobes from the margins, 2-valved, the margins of the valves involute in the young condition but opening at maturity; each enclosing a single sporogonium which does not completely fill the cavity. Perianth absent. Capsule subglobose, shortly pedicellate, with a large foot, irregularly dehiscing at the apex. Elaters 2-3-spiral.

37. **Reboulia hemispherica** (L.) Raddi.

Reboulia hemispherica Raddi. Opusc. Scient. di Bologna II, p. 357 (1818),
Mindal pangiensis Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 346 (1916).

Dioecious or monoecious. In dense patches of overlapping individuals, deep green, with usually purple margins. Thallus dimensions very variable, 10-30 mm. long and 3-8 mm. broad, lobes oblong or obovate with emarginate or bilobed apex, margins ascending, crenulate, sometimes purple. Dorsal epidermal cells 4-6-angled, with walls slightly thickened, trigones thick. Pores a little elevated, with 3-5, (up to 8) concentric rings of 6-8 (-10) cells each, radial walls and trigones thickened. Ventral surface purple; scales purple, imbricate, in one row on each side of the midrib, obliquely lunate, reaching halfway to the margin, with two linear appendages. Midrib thick, gradually passing into the lamina ending in the one cell thick margin. Male receptacle at the apex of a lobe, small, disciform, surrounded by chaffy scales. Stalk of the female receptacle about 30 mm. long, receptacle hemispherical, 4-9-lobed. Capsule spherical; wall of a single layer of cells. Spores spherical, brown, reticulate-lamellate with a broad wing, 3-4 areoles in the diam., 65-75 μ. Elaters 2-3-spiral, coiled, 300-400 μ long, occasionally branched.

Hab. Moist rocks.

Distrib. Common throughout the hill area. Very widely distributed from 5,000 to 13,000 feet. *Mussoorie; Dalhousie; Simla*; Pangi; Kulu; Spiti; Lahul,

PLATE XV.

REBOULIA HEMISPHERICA. 1–5.

1. A male plant.
2. Two female plants.
3. A ventral scale.
4. Vertical section through a pore.
5. T. S. stalk of the female receptacle.

MINDAL PANGIENSIS. 6—8.

6, 7, 8. Three plants.

PLAGIOCHASMA INTERMEDIUM. 9–12.

9. A fertile female plant.
10. Vertical section through pores.
11. A ventral scale.
12. Appendage of the ventral scale.

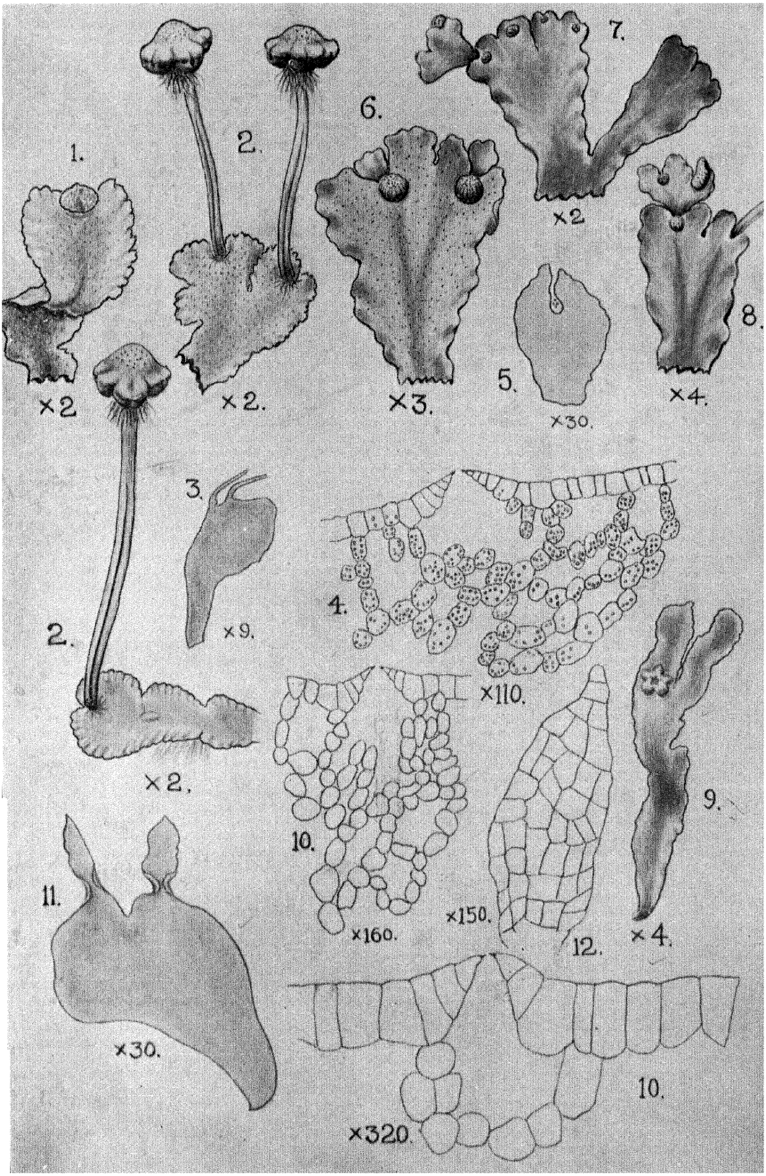

PLATE XV.

Kyelang; S India, *Madras* (Iyengar), Nilgiris (Rangachariar), Tinnevelly Hills (Rangachariar); Kaghan Valley (N. A. Qizilbash).

Note:—The plant described as *Mindal pangiensis* by the writer (Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 346, 1916) is very incompletely known. It is undoubtedly very near *Reboulia*, and possibly may be a mere form of *Reboulia hemisphaerica*. It differs from the latter in the continued growth of the thallus after the formation of the male and female receptacles by means of apical adventitious shoots; in the size of the pores which are bounded by 2 or 3 rings of 8 cells each; in the small number of the involucres, which are only 1 or 2 on the small receptacle; and lastly in the size of the spores and elaters. These last were described from stray individuals sticking to the walls of the capsule and are: spores yellowish, reticulate, 30 μ in diam., and elaters 180 μ, closely trispiral. Even last year (1928) while passing through Pangi where the plant was first collected I could not secure any good material. Until the plant is better known it is as well that it may be treated as a variety of *Reboulia hemisphaerica*, especially as that plant itself is very variable.

The specimens from Spiti are in an unsatisfactory condition. The plants are narrow with purple margins; air-chambers small in several layers; ventral scales purple, with 1 or 2 appendages, appendage entire, purple, lanceolate, acuminate,

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XIX. PLAGIOCHASMA L. et L.

Plagiochasma L. et L. in Lehm. Pug. Pl. IV, p. 13 (1832).

Monoecious or dioecious. Plants large, caespitose, in large patches, green. Chambers narrow, in several layers, empty. Pores sometimes with thick radial walls of the cells bounding them. Scales in 2 rows, with appendages. Male receptacle sessile, usually horse-shoe-shaped, surrounded by linear scales; papillae small; air-chambers with simple pores between the antheridia. Female receptacle sessile when young, usually stalked at maturity; stalk arising from the dorsal side of the thallus, without a rhizoid-furrow, with scales at the base and apex. Receptacle more or less concave on the dorsal surface (in the Indian species), with barrel-shaped pores, 2-9-lobed, involucres large, inflated, bivalved, margins of the valves involute in the young condition, one of which opens out at maturity while the other remains folded inwards, each containing one archegonium and later on one sporogonium. Calyptra thin. Capsule short, with a large foot, opening by an indistinct lid. Capsule wall thin, one layered, cells without annular or spiral bands, lid 2-3 cells thick. Spores, large, yellow, tetrahedral. Elaters rather short, bi- or tri-spiral, sometimes uniformly thickened without spirals, yellowish, occasionally furcate.

Note.—The margins of the involucral valves in the young condition are bent inwards, projecting into the cavity of the involucre. Later on when the capsule is ripe and the involucre opens, one of the margins spreads out and opens outwards, while the other becomes more closely pressed along the inner surface of the valve and never opens out. In the allied genus *Reboulia* the young valves have their margins similarly bent inwards but at maturity both valves open outwards.

The female receptacles are distinctly dorsal in all the species except *P. articulatum* in which they are at first terminal but the thallus goes on growing invariably by an adventitious shoot immediately after the formation of the receptacles whether the latter are fertilised or not, so that a distinct line of articulation is always clearly visible in that species. Sometimes in *P. appendiculatum* also growth stops partially after the formation of the receptacles and a similarly articulated appearance is produced but a close examination shows this to be only apparent and, in any case, partial.

Key to the Species.

1 { Thallus distinctly articulated, female receptacle borne at the articulation .... *P. articulatum.*
Plants as a rule not articulated, female receptacle always dorsal 2

2 { Lobes broad, obcordate. scale appendage large, broad, strongly constricted at the base *P. appendiculatum.*
Lobes narrow, linear .... 3.

3 {Scale appendages not constricted..............................*P. simlensis*
{Scale appendages constricted..............................*P. intermedium.*

38. Plagiochasma articulatum Kashyap.

Plagiochasma articulatum Kashyap, New Phyt. Vol. XIII, p. 320 (1914).

Monoecious. Thallus 2-5 cm. long and 6-8 mm. broad; lobes oblong-obovate, flat, with undulate margins, apex notched. Dorsal surface dark green, epidermal cells 5-6-angled, walls thin, angles thickened. Dorsal layer well developed, chambers empty, in several layers. Pores simple, inconspicuous, bounded by 3 series of 7 or 8 cells each. Ventral surface purple; scales purple, overlapping, each with 2 or 3 long, narrow, purple, appendages, which bend over the growing point. Midrib inconspicuous, gradually passing into the lamina, ending in an acute margin. Receptacles always terminal to begin with, becoming dorsal by the formation of apical adventitious shoots and therefore, situated on the line of junction in the middle. Male receptacles formed one after the other, or a male receptacle may be followed by a female receptacle; horse-shoe-shaped, surrounded by small scales, and with 2 growing points; pores on the receptacle tissue simple. Stalk of the female receptacle none or up to 2 mm. long. Receptacle with 3-4 lobes. Capsule wall of a single layer of cells except at the top. Spores yellowish, reticulate-lamellate, 60-80 μ in diam. (including the wing), 2-4 reticulations in the diameter (excluding the wing), wing 12 μ broad, more or less lobed, surface punctate. Elaters normally bispiral, 220-260 μ long.

Hab. Rocks, etc. The same as that of *P. appendiculatum*, but more adapted to drier localities.

Distrib. Common throughout the Outer and Kumaon Himalayas up to about 8,000 feet; also, Ladak, *Leh* 11,000 feet; sometimes coming down to the plains, *Lahore* etc.; *Ootacamand* (Rangachariar); Nilgiris (Sedgwick); *Bombay*, *Panchgani* (Blatter).

Note.—Although the plant often occurs along with *P. appendiculatum*, it is more commonly met with in dry localities, is generally much smaller and distinctly xerophilous. The poor plants of *P. appendiculatum* sometimes resemble this species very much. The elaters, like those in *P. appendiculatum.* sometimes do not develop the spiral bands. Stalk of the female receptacle may or may not be developed. It resembles *Reboulia hemispherica* in the general appearance of the thallus and the form of the scales.

Both the male and female receptacles are at first terminal. Shortly after, however, growth of the lobe is continued. In other words an apical adventitious shoot is formed. There is thus always a distinct line of articulation between the old and the new part of the lobe and the receptacle is situated between the two. In *P. appendiculatum* and other species, there is never any stoppage of growth and the receptacles are distinctly dorsal. *P. articulatum* shows clearly how the position of the receptacle has been shifted from the apex to the dorsal side, and how a form like *Reboulia* could have given rise to a form like *Plagiochasma.* Apical adventitious shoots are common in *Reboulia.* The main difference between the two genera is the form of the female receptacle. Compare also the genera *Preissia* and *Stephensoniella* as regards this character.

39. Plagiochasma appendiculatum L. et L.

Plagiochasma appendiculatum L. et L. Pug. IV, p. 14 (1832).

Monoecious. Thallus forming large patches, thick, 1-4 cm. long and 4-10 mm. broad, dichotomously divided, occasionally with adventitious ventral shoots; lobes oblong obcordate; dorsal surface smooth, slightly concave; margins undulate, ascending, crenulate. Areolae not visible to the naked eye, epidermal cells large, 5-6-angled, angles thickened. Dorsal layer well developed, chambers empty in several layers. Pores large, bounded by 3 or 4 rings of 6-10 cells each, radial walls thickened, nodulose. Ventral surface purple; scales in 1 row on each side of the midrib, purple, broadly lunate, body with 1 or 2 appendages, reaching half way to the margin, bent over the apex; appendage large, usually hyaline, entire, rotund or ovate, obtuse, occasionally purple, ovate-lanceolate and, acute. Midrib not conspicuous below, gradually passing into the lamina. Male receptacle horse-shoe-shaped, sometimes once or twice furcate, surrounded by small scales, with distinct growing points; pores on the receptacle simple. Female receptacles sessile or stalked. Receptacle usually with 5 or 6, often as many as 9, lobes. Capsule wall of a single layer of cells except at the lid, lid of 3 layers of cells, cells equally thickened on all sides. Spores yellowish, reticulate-lamellate, 50-90 µ (including the wing), 2-3 reticulations in the diameter (excluding the wing), wing broad, 12 µ, entire or slightly lobed, surface of wing finely punctate. Elaters 220-290 µ, bispiral; often with uniformly thick walls and without spirals.

Hab. Rocks, etc.

Distrib. Exceedingly common in the Outer, and the Kumaon Himalayas up to 9,000 feet, sometimes coming down to the plains. *Lahore*, *Rawalpindi*, *Saharanpur*, *Hardwar*, *Dehra dun*, etc.; Jammu *Patni pass*; *Simla*; *Mussoorie*; *Nainital* (Baini Prasad); Nilgiris (Rangachariar).

Note.—Stephani mentions that the receptacle has 2 or 3 involucres, but in the specimens examined by me there are usually 5 or 6 involucres, though as many as 9 are sometimes seen. According to him the scales bend over the margins but I have not found any specimens in which the scales were more than half way towards the margin.

The large and broad lobes, with a smooth dorsal surface, forming usually large patches, sometimes extending to several feet, along with the large hyaline appendages conspicuously bent upwards at the growing point, distinguish this species from the others. The appendages are usually rounded or ovate, obtuse and hyaline. The epidermal cells have thin or slightly thickened walls and trigones are as a rule much thickened. The number of cells bounding the pores is very variable. There are usually 6-8 cells in each ring but as many as 10 may be present, and stomata are found in the same piece of the thallus with any number of cells between 6 and 10. Specimens from Hardwar show some peculiar characters. The epidermal cells are thin-walled and the trigones are not thickened. The scale appendages as usual are large, one or two to each scale, but ovate or ovate-lanceolate, acute, and purple. It may appear from a combination of these characters that the plants belong to another species. The great variation in liverworts, however, should be borne in mind. In perfectly typical specimens which would be easily recognised as *P. appendiculatum* the epidermal cells may be thick- or thin-walled and the scale appendages may be acute. The colour of the scale appendages and the absence of trigones are not sufficient characters to separate the Hardwar specimens as a distinct species. Further examination of the plant would no doubt bring to light other variations.

The plant is usually met with in moist places. In favourable localities the male receptacle is often seen branching once or twice, with long narrow lobes, in which the antheridia are borne distinctly in an acropetal order. Several receptacles may be formed one after the other. The female receptacle is usually perfectly clearly dorsal, and several receptacles may be formed one after the other, especially when they are not fertilised. The relative position of the male and female receptacles is very variable. A male receptacle may be formed in front of, behind, or beside the female receptacle on an adjacent lobe. Sometimes bisexual receptacles are met with. Occasionally growth is more or less stopped under unfavourable circumstances after the formation of the receptacle and is resumed later. In these cases it appears as if the receptacle was terminal and growth had been continued by an apical adventitious shoot. It may then become difficult to distinguish this species from *P. articulatum*, but a little careful examination will show that the two parts of the thallus are absolutely continuous at least in some portion and there is never a complete line of articulation as in *P. articulatum*.

Sometimes the elaters develop no spiral bands, probably when the plants do not get sufficient moisture owing to the rains having stopped while development was still going on. The spores and elaters vary in size to some extent and as a rule they vary inversely to each other.

Some of the cells in the female receptacles and sometimes even in the thallus are brown in colour and contain oil.

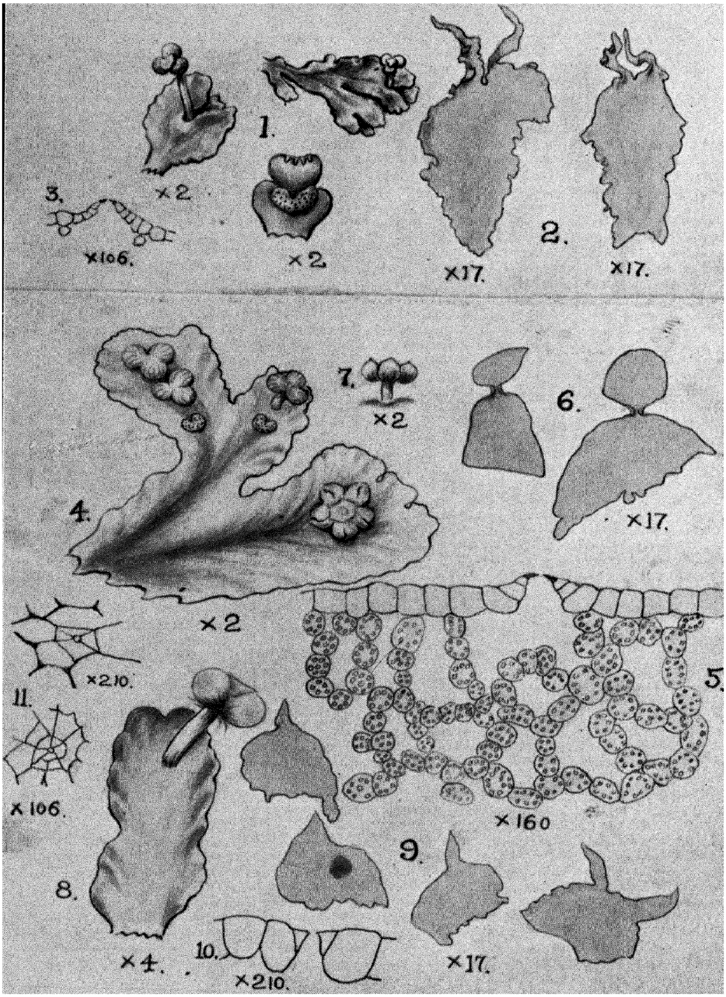

PLATE XVI.

PLATE XVI.

PLAGIOCHASMA ARTICULATUM. 1—3

1. Three male and female plants. 2. Two ventral scales.

3. Vertical section through a pore.

PLAGIOCHASMA APPENDICULATUM 4—7

4. A plant with male and female receptacles.

5. T.S. of thallus.

6. Two ventral scales. 7. A female receptacle.

PLAGIOCHASMA SIMLENSIS. 8—11.

8. A plant. 9. Four ventral scales.

10. Vertical section through a pore. 11. Two pores from above.

40. **Plagiochasma simlensis** Kashyap.

Plagiochasma simlensis Kashyap, Jour. Bomb. Nat. Hist. Soc. Vol. XXV. p 279 (1917).

Monoecious or dioecious. Closely creeping, bluish green, dichotomously branched, up to 15 mm. long and 4 mm. broad; lobes narrow, linear; apex rounded ; margin entire or slightly crenulate, purple; dorsal surface smooth, plane. Areolae not distinct; epidermal cells thin-walled, angles not thickened. Dorsal layer shallow. Pores minute, simple, bounded by 4 or 5 cells. Ventral surface purple ; scales purple, overlapping, not reaching the margin, triangular, entire, appendage not sharply constricted off from the body, purple or hyaline, ovate to lanceolate, usually ending at the apex in a 2-celled filament. Cross section of the thallus biconvex in the middle, gradually thinning towards the margins. Male receptacle middorsal, either on different lobes of the thallus bearing female receptacles or on different plants, cushion-like, circular or notched anteriorly. Female receptacle sessile or shortly stalked; stalk, if present, up to 2 mm. long; receptacle concave dorsally. Sporogonia, 1 or 2. Spores broadly reticulate-lamellate, 3 reticulations in the diam, (excluding the wing), wing broad, 8 μ, punctate, finely ciliate about 112 μ in diam. Elaters closely 3-4-spiral, broad, occasionally branched, 340-400 μ long

Hab.	Near a stream.
Distrib.	Outer Himalayas, *Simla*: S. India, *Kodai Kanal* (Rangachariar)

Note.—Stephani (Sp. Hep. Vol. I, p. 81) has described a plant under the name of *P. nepalensis* from Nepal, which from the description appears to be the same as *P. simlensis*.

41. **Plagiochasma intermedium** Ldbg. et G.

Plagiochasma intermedium Ldbg. et G.; G. L. et N. Syn. Hep. p. 513 (1844).

Dioecious. Plants forming patches, thallus up to 25 mm. long and 4 or 5 mm. broad, simple or slightly dichotomous, frequently with apical and ventral innovations; lobes strap-shaped; dorsal surface green, sub-plane: margins thin, purple, raised, almost entire to dentate. Epidermal cells polygonal, walls and trigones rather thick. Dorsal layer well developed. Pores large, bounded by 3 or 4 rings of 7 to 9 cells each, radial walls slightly thickened. Ventral surface purple ; scales purple, overlapping, lunate, appendaged, appendages 2 or 3, oblong-lanceolate, constricted at the base, entire, acute. Midrib broad, gradually passing into the wings. Male receptacle at the apex on the main thallus, often with an adventitious shoot in front. Female receptacle sub-sessile, or very briefly stalked, on the dorsal surface in the middle. Receptacle concave above, with 1-4 involucres, scaly below, scales linear-lanceolate. Spores brown, reticulate-lamellate, winged, wing broad, entire, reticulations 2-3 in the diam. (excluding the wing), 70 (66-95) μ. in diam. Elaters concolorous, uniformly thickened, without spiral bands, 250 μ.

Hab.	On a wall.
Distrib.	Nurpur, (Pathankot—Dalhousie road) about 2.500 feet.

Note.—The species has not so far been described from India. Stephani (Sp. Hep. Vol. 1, p. 79) describes it from Mexico, while Evans (Bull. Torr. Bot. Club 42: 1915, p. 301) describes it from several localities in America and gives China and Japan as its range of distribution. The characters agree with the descriptions of the above writers with very slight differences. Evans says that the plant is monoecious, that the walls of the epidermal cells are thin, and that the elaters are without or with only rudimentary spirals. According to Stephani the elaters are without spirals. My specimens agree closely with the description given by Stephani.

As was pointed out by the writer in connection with *P. articulatum* and *P. appendiculatum* (New Phyt. Vol. XIII, 1914, pp. 318-323) spirals on the elaters may or may not be present in the same species, and the absence of spirals, therefore, has no specific importance. Probably the absence of spirals is associated with a decrease in the amount of moisture available at the time when the spores and elaters are approaching maturity. According to Evans the spores are usually verriculose and occasionally reticulate, but the few spores seen by me were all reticulate as stated in the description. The length of the stalk is also very variable.

The following species have been described by Stephani from the Himalayas but have not been found by the writer

42. **Plagiochasma cordatum** L. et L.

Plagiochasma cordatum L. et L. Pug. IV. p. 13 (1832).

Monoecious. Thallus up to 20 mm. long, and 10 mm. broad, dorsal surface plane, margins ascending, attenuate, wavy, crenulate. Stomata large, bounded by 4 series of 6 or 7 cells each. Ventral surface not coloured, slightly convex : scales large, pink, imbricate, oblique, semilunate ; appendages 2, long, parallel, linear, acute, margin coarsely toothed (erosodentatis). Male receptacle on branches arising either from the apex or from the sides of the midrib. Female receptacle stalked ; stalk up to 7 mm. long, thin, apex slightly scaly. Receptacle concave on the dorsal surface, smooth. Involucres 2 Spores 68 μ. Elaters 290 μ, bi- or tri-spiral, spirals narrow.

Hab. Nepal (Wallich). Himalaya (Hooker. Duthie).

43. **Plagiochasma quadricornutum** St.

Plagiochasma quadricornutum St., Sp. Hep. Vol. VI. p. 9 (1917).

Plants dioecious, large, robust, rigid, yellowish, on soil or rocks, in patches. Thallus 25 mm. long and 5 mm. broad, simple or furcate, margin minutely crisp, reddish. Stomata large, low, bounded by several rings of 6 cells each, inner pore closed by four conical radially converging cells. Midrib narrow, slightly produced. Ventral scales large, purple, long appendaged, appendage linear, cuspidate, entire. Male receptacle not seen. Stalk of the female receptacle short, thick. Receptacle globose, margin slightly emarginate involucres four, mussel-shell-shaped, opening wide, entire. Rest not seen.

Hab. Himalaya, *Simla* (Long).

* * * * *

XX. SAUCHIA Kashyap.

Sauchia Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 347 (1916).

Plants occurring singly or in patches, small, light green, dorsal side spongy. Chambers in one layer, directed forwards obliquely, empty, very wide in older parts. Pores simple, slightly raised. Ventral surface greenish; midrib thick; scales scattered, hyaline, small, triangular or ovate, entire, acuminate. Antheridia on the dorsal surface of short ventral shoots, papillae conical. Female receptacle stalked, in the fork of 2 lobes; stalk with one rhizoid furrow containing a few tuberculate rhizoids, naked at the base, paleaceous at the top. Receptacle 4-lobed, with 4 bivalved or slightly tubular involucres under the lobes; receptacle tissue absent, stomata none, involucre wall with large chambers opening by irregular fissures inwards. Archegonium one in each involucre. Sporogonium with well developed foot when young, seta a mere constriction, capsule wholly included, wall of one layer of cells, cells with spiral, annular, or semiannular bands, annular bands sometimes branched. Elater-like cells attached to the base and top of the capsule. Spores tetrahedral, margin crenate. Elaters closely trispiral, often branched.

44. **Sauchia Spongiosa** Kashyap.

Sauchia spongiosa Kashyap, Jour. Bom. Nat. His. Soc. Vol. XXIV, p. 347 (1916).

Monoecious. Plants singly or in patches, thallus spongy, light green, thick, once or twice forked, often with numerous small adventitious shoots from the ventral surface just within the margin, lobes broad, oblong, 5-10 mm. long and 4 mm. broad, apex notched rather deeply, margin entire or slightly toothed, slightly raised. Dorsal surface areolated, flat or with a narrow shallow indistinct groove in the posterior part; epidermal cells with chloroplasts, walls thin, angles not thickened. Dorsal layer deep. Pores simple, slightly raised, not well differentiated, surrounded by 3 series of 6-8 cells each, innermost cells usually collapsed, circular when young, drawn out when old. Air-chambers wide and deep, in one layer, empty, directed

PLATE XVII.

SAUCHIA SPONGIOSA. 1—9.

1, 2. Two female plants.
3. A male plant, note the ventral male shoot.
4. A male shoot.
5. T. S. of thallus.
6. Four pores. The dots in one case represent the Chloroplasts.
7. A ventral scale.
8. T. S. of Stalk of the female receptacle.
9. Two scales from below the female receptacle.

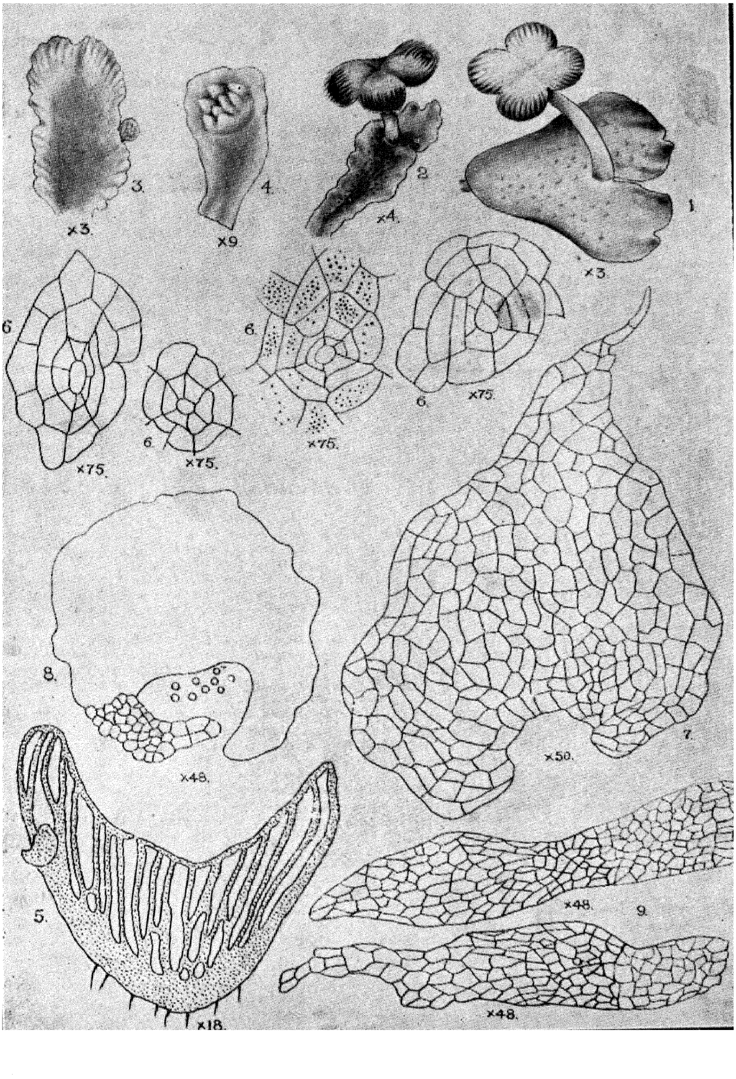

PLATE XVII.

forwards obliquely. Ventral surface greenish; scales scattered. hyaline, small, triangular or ovate, entire, acuminate. Midrib prominent below, gradually passing into the raised margin. Antheridia on short ventral shoots in a mid-dorsal cluster, papillae long, conical, 4-8. Female receptacle in the fork between two lobes, stalked; stalk up to 7 mm. long, with 1 rhizoid furrow containing a few tuberculate rhizoids, naked at the base but paleaceous at the top; scales persistent, lanceolate, with a thin-walled proximal and a thick-walled distal half. Receptacle 4-lobed, with 4 bivalved or slightly tubular involucres; receptacle tissue absent. stomata none; involucre walls with large chambers opening by irregular fissures inwards. Perianth absent; calyptra thin. Archegonium one in each involucre. Sporogonium with a well developed foot, seta a mere constriction, capsule 880 μ in diameter. Spores 60-64 μ, winged, wing narrow, crenate-lobate. Elaters closely trispiral, 200-250 μ long. Elater-like cells small. Some elaters and many short elater-like cells fixed to the base and apex of the capsule, projecting into the cavity.

Hab.	On moist shady rocks or actually under cold flowing water.
Distrib.	Middle and Main Himalayas 9,000-14,500 feet. Above *Alwas* on the Pangi Road, 9,000 feet; both sides and top of *Rotang Pass*, 13,400 feet; beyond Baralacha Pass, 14,500 feet; Chandra Valley, *Manh Pass*.

Note:—This species was described (Jour. Bomb. Nat. Hist. Soc. Vol. XXIV, p 347 1916.) from some scanty material from Chamba—Pangi Road. In 1928 more material was collected from this and several other localities. The original description has been amplified from these specimens.

The capsules are not quite ripe in the specimens. Spores and elaters are still brownish, and the spores are without fully developed surface marks. In the oldest parts the stomata become disorganised and the chambers open by the whole width and are visible to the naked eye. The chambers sometimes contain the eggs of some insect which resemble the antheridia. They are white in colour and oblong-cylindrical in shape.

The male shoots resemble those of *Targionia* and some *Fimbriarias* in possessing a cylindrical stalk-like and an expanded terminal portion which bears the antheridia.

The difference in the thickness of the cell-walls in the proximal and distal half of the scale is more marked in the case of the scales at the top of the stalk of the carpocephalum than in the case of scales from the thallus.

Allied to *Sauteria*, from which it differs in having thin-walled cells around the pores and its delicate texture. Resembles *Stephensoniella brevipedunculata* in appearance and texture, The latter, however, occurs at lower levels.

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The following species *Sauteria alpina* has been described by Stephani, but has not been seen by me.

XXI. SAUTERIA Nees.

Suteria Nees, Nat. eur. Leb. IV. p. 139.

Plants thallose, small, green. Thallus thick, dichotomously divided or with innovations from the side of the midrib; sterile lobes ligulate, fertile ones broadly ob-cordate; dorsal surface almost plane. Dorsal layer narrowly cavernous, chambers in one layer. Stomata small, simple, bounded by a ring of 5 or 6 cells with thick radial walls. Midrib strongly produced ventrally; ventral scales in 2 or 4 rows, small, delicate, scarcely imbricate. Antheridial group not sharply marked off, without scales, irregularly arranged, in the middle of the thallus, ostioles narrow and hyaline. Female receptacle terminal. Stalk long with one rhizoid furrow, naked at the base, sometimes paleaceous at the top. Central disc of the receptacle small, stomata none, deeply divided into 3-5 decurved, obovate, often unequal lobes. Involucre tubular, apex truncate, wide, open. Calyptra thin. Foot small, seta small or nil, capsule globose, not exserted, dehiscence irregular, wall with well developed semi-annular bands. Spores more or less papillate. Elaters fusiform, curved, bi- or tri-spiral, obtuse.

45. **Sauteria alpina** Nees.

Sauteria alpina Nees, Nat. eur. Leb. IV. p. 143.

Monoecious. Thallus usually up to 12 mm. long, green in the middle, hyaline at the margins, twice as broad as thick, ventrally subangular, convex, and in section, therefore, the thallus broadly triangular. Dorsal layer shallow; epidermal cells not thick-walled. Ventral scales imbricate, in 4 rows, hyaline, oblique from a broad base, formed of large irregular cells, apex gradually acuminate, upper half coarsely and irregularly dentate or sublaciniate with clavate cells. Female receptacle stalked, stalk up to 20 mm. long, hyaline, furrow deep with obtuse lips. Scales on the ventral side of the receptacle large, oblong, obtuse. Capsule distinctly pedicellate, reddish-brown. Spores deep brown, 59 μ, densely papillose. Elaters usually up to 200 μ, bi-spiral.

Hab. Kaschmir, Liddar Valley, 13,000 feet (Duthie).

* * * *

XXII. ATHALAMIA Falconer.

Athalamia Falconer, Trans. Linn. Soc. Vol. XX, p. 397 (1851).

Plants green, in patches, on rocks or earth, branching dichotomous. Air-chambers narrow, empty, in one layer; pores simple, bounded by cells with usually more or less thick radial walls. Ventral scales scattered without distinct appendages. Antheridia usually behind the stalk of the female receptacle, ostioles forming a cushion or scattered in zigzag rows, conspicuous. Female receptacle dorsal, stalked; stalk without a rhizoid-furrow, sulcate, paleaceous only at the top. Tissue of the female receptacle minute or nil, a short knob being formed where involucres meet, stomata absent, number of involucres variable. Involucres bi-valved, directed upwards, walls of the involucre with chambers opening inwards by long fissures. Archegonium one in each involucre. Sporogonium with a well developed foot and a seta. Capsule exserted, wall of one layer of cells with thick bands. Capsule dehiscing by 4 or 5 irregular valves, apex with a few elater-like cells hanging into the cavity. Spore brown, papillate. Elaters 2-3-spiral.

46. **Athalamia pinguis** Falc.

Athalamia pinguis Falc., Trans. Linn. Soc. Vol. XX, p. 397 (1851). Kashyap, New Phyt. Vol. XIV, 1915, p. 10.
Clevea Gollani Levier; St., Sp. Hep. Vol. VI, p. 5. (1917).

Monoecious. Plants growing upwards from a thick base and again bending the thick apex into the soil. Thallus 10-15 mm.

broad, simple or forked once or twice, lobes not divergent, light green, fleshy, wings wide, very thin, erect, dorsal surface deeply concave, densely papillate. Epidermal cells 5-6-angled, elongated antero-posteriorly, walls thickened. Pores minute, slightly raised, each bounded by 1 ring of 4 or 5 cells, radial walls of cells very thick, giving the pore a star-like appearance. Air-chambers very narrow, slit-like on the midrib, slightly broader in the wings. Ventral surface greenish or hyaline; covered with numerous scales, scales white, large, triangular or lanceolate, entire, not appendaged. Midrib prominent below, mycorrhizal, rather suddenly passing into the lamina. Antheridia a few, generally behind the stalk of the female receptacle, sometimes in front of it, and occasionally on distinct lobes, in 2 rows, ostioles conspicuous. Female receptacle arising from the dorsal surface on the midrib; two may be formed one after the other. Young receptacle surrounded by scales, scales smaller than the ventral scales and with numerous cells projecting from their margins, later carried to the top of the stalk; stalk up to 6 mm. long and 1 mm. thick, circular or more or less triangular in cross section, sulcate. Receptacle with 3-5(-8) involucres; involucres inflated, upturned, 2-valved, each with one archegonium; receptacle tissue nil or a minute knob without stomata. Sporogonium one in each involucre, but not in every involucre; capsule with a well developed foot, fully exserted and directed upward, seta up to 1·5 mm. long, cells of the capsule wall with annular bands. Spores brown, tetrahedral, with obtuse papillae, appearing reticulate with a toothed margin in surface view, 65-70 μ in diam. Elaters trispiral, sometimes branched, 140-200 μ long. From the top of the capsule hang a few short elaterlike cells.

Hab.	Exposed slopes
Distrib.	Very common in the Outer and the Kumaon Himalayas, 5,008 to 8,000 feet. *Mussoorie*, *Simla*, Kulu, Ravi valley, etc.

Note:—The thick fleshy thallus, upturned thin wings, and the tuft of white scales at the apex distinguish this species from other thallose forms. The scales may occasionally have a cell projecting from the margin. The apex becomes thickened at the end of the season and is directed downwards into the soil, where it persists, while the rest of the plant dies in winter This apical portion is smooth and without any scales, which are found

PLATE XVIII.

ATHALAMIA PUSILLA. 1—6.

1, 2. Two fertile plants. No. 2 shows a dehiscing capsule.

3. L. S. of thallus (only a portion).

3a. T. S. of thallus.

4. Two pores from above.

4a. Vertical sections through two pores. The lower one shows the side view.

5. A ventral scale.

6. A scale from a young female receptacle.

ATHALAMIA PINGUIS. 7—13.

7, 8. Two plants, note the antheridial papillae, an.

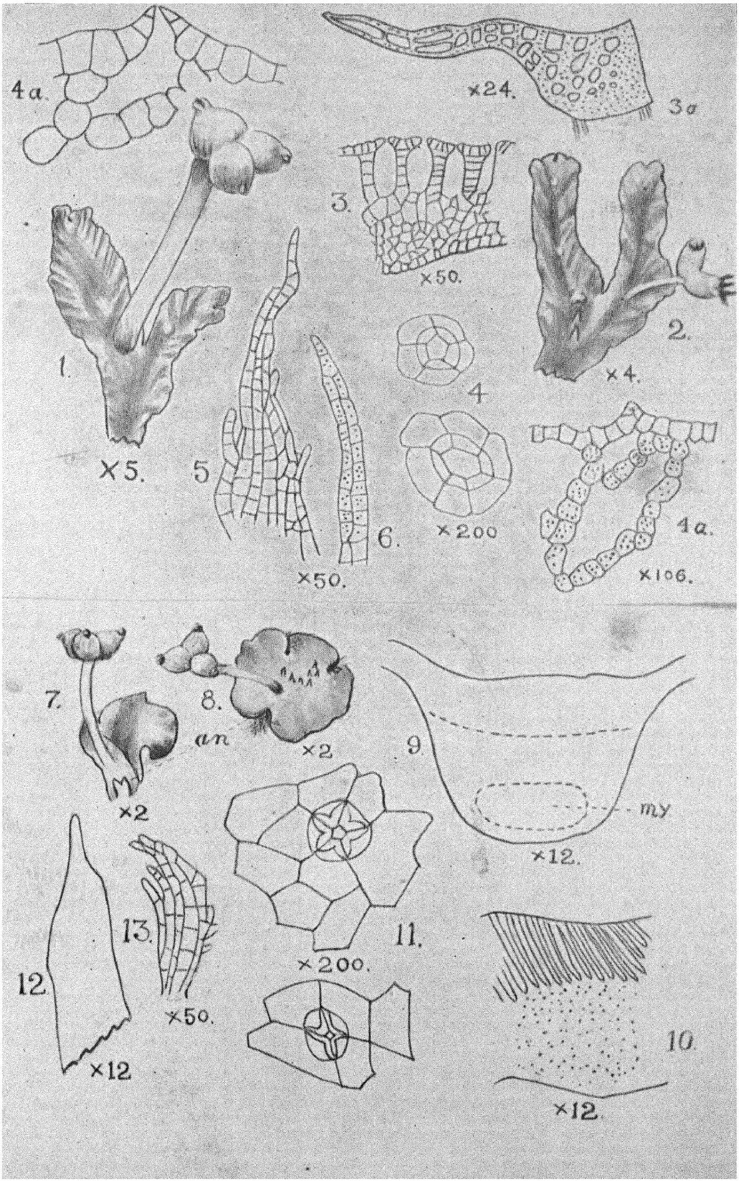
9. T. S. of thallus; my, the mycorrhizal region.

10. L. S. of thallus (only a portion).

11. Two pores from above.

12. A ventral scale.

13. A scale from a young female receptacle.


4a.
×24.
3a
3.
×50.
1.
×5.
5
6.
×50.
4
×200
2.
×4.
4a.
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an
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8.
×2
9.
my
×12.
11.
×200.
13.
×50.
12.
×12
10.
×12.

PLATE XVIII.

on its lateral sides, and bears only a few rhizoids.

The scales on the young female involucre resemble the ventral scales of the thallus of *Athalamia pusilla* described later.

47. **Athalamia dioica** Kashyap.

Athalamia dioica Kashyap, Jour. Bom. Nat. Hist. Soc. Vol XXIV, p. 348 (1916).

Dioecious. Thallus thick, fleshy. green, once or twice forked, lobes oblong, up to 6 mm. long and a little less broad. Dorsal surface with a white metallic lustre. Stomata simple, surrounded by 5 or 6 cells, with thick radial walls. epidermal cells thin-walled. Air-chambers rather wider than those of *A. pinguis*. Scales triangular or ovate, acuminate, entire, produced into a filament of a few cells. Antheridia in 2-4 zigzag or straight rows on the mid-dorsal line or a definite raised naked receptacle. Capsule only slightlv exserted. Spores deep brown, with numerous high conical papillae, 50-55 μ in diam. Elaters brown, rather closely trispiral, 200-250 μ long.

Hab. On road-side.

Distrib. Pangi, about 7,000 feet, between *Kilar* and *Sauch*.

Note:—Doubtfully distinct from *A. pinguis*.

48. **Athalamia pusilla** Kashyap Nov. Comb.

Gollaniella pusilla St. Hedwigia. Bd. LXIV, p. 74 (1905).
Kashyap, New Phytologist Vol. XIV, p. 14, (1915).

Usually monoecious, occasionally dioecious. In large patches on bare rocks or crumbling hard earth. Plants small, delicate, thin, closely creeping, from a thick narrow base, up to 15 mm. long and usually about 1·5 mm. broad, with a dorsal groove; once or twice forked, rarely with ventral innovations; lobes linear to obovate, notched at the apex, margin thin, wavy, purplish, ascending. Dorsal surface with inconspicuous stomata; epidermal cells 5-8-angled, walls thin. Pores small, inconspicuous, bounded by 2 rings of 5 or 6 cells each, radial walls of cells usually thin, sometimes slightly thick. Dorsal layer shallow, with small, empty, air-chambers. In a cross section the chambers in several layers in the middle, in only one or two layers in the wings, wing usually consisting of an upper and a lower layer of cells seperated by the air-space. Midrib projecting ventrally, rather suddenly passing into the wings. Ventral surface greenish or sometimes reddish ; scales scattered, delicate, hyaline or reddish, lanceolate, acuminate, numerous cells projecting outwards at the margins. apex formed of a filament of 4 or 5 cells, shorter filaments sometimes projecting from the sides also, cells of scales with chloroplasts. Antheridia few, usually behind the stalk of the female receptacle, sometimes in front of it; arranged in two zigzag rows, or on a more or less well-developed cushion, papillae hyaline. Female receptacle dorsal, on the midrib, very small while young, covered by linear scales, cells of the scales with chloroplasts. Receptacle tissue nil. Involucres 1 or 2, rarely 3. Archegonium one in each involucre. Stalk developed only if the archegonium is fertilized, up to 10 mm. long and fairly thick, sulcate, naked, covered at the top by linear scales. Capsule with a seta 1-1·5 mm. long, fully exserted. Cells of capsule wall with annular bands. Dehiscence by irregular recurved valves. Spores brown, with numerous high papillae, 45-56 µ in diam. Elaters bispiral brown, 140-180 µ long. A few short elater-like cells with annular bands project into the cavity of the capsule from the base and the apex.

Hab. Moist and shady places,

Distrib. Common in the Outer and the Kumaon Himalayas, 6,000 to 10,000 feet. *Simla*; Kulu, *Dulchi pass*; Lahul, *Kyelang*; *Mussoorie*, *Joshi math, etc.*

Note :—The cells bounding the pores are usually thin-walled Sometimes, however, the radial walls of the cells are slightly thickened. The radial walls are never very thick and the pores are never star-shaped.

Stephani described this plant under the name *Gollaniella pusilla* and the description was amplified by me (New Phyt. Vol. XIV, p. 14, 1915). The ripe capsule wall, consisting of a single layer of cells, has, in my specimens, well developed thick annular and spiral bands—not semi-annular bands as described by St~~a~~ephani - on ~~of~~ the cell walls. In view of the close similarity of the chief characters between *Athalamia pinguis* and this plant it is not necessary to put it in a separate genus, and *Gollaniella* has, therefore, been merged into *Athalamia*.

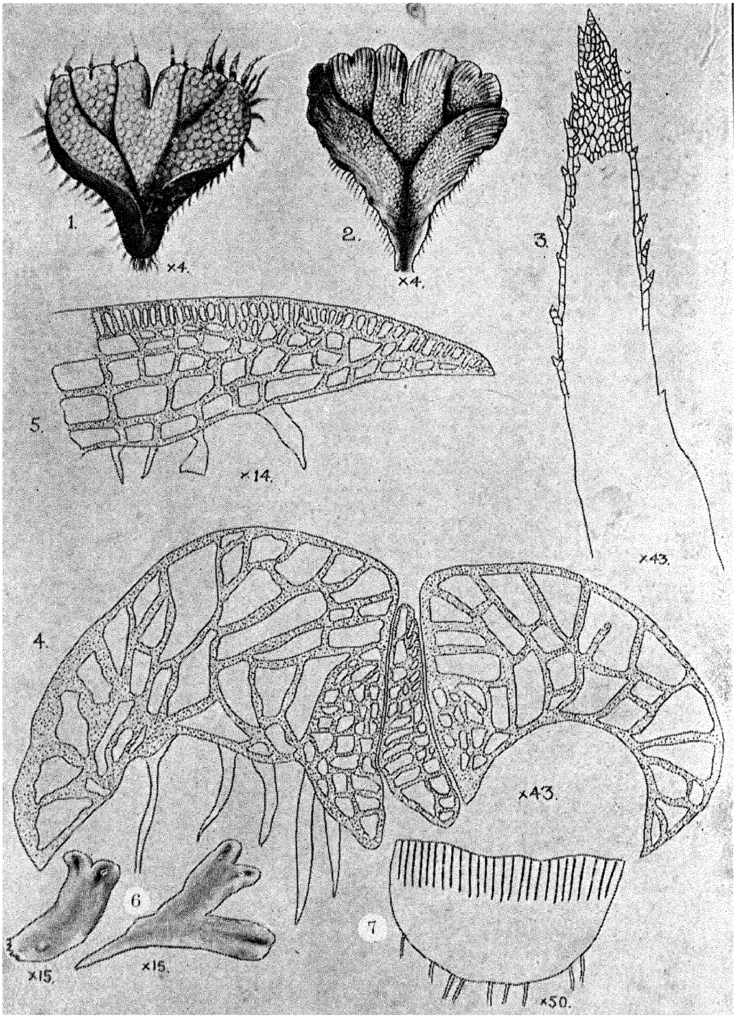

PLATE XIX.

PLATE XIX.

RICCIOCARPUS NATANS. 1—5.

1. Floating form.
2. Land form.
3. Ventral scale from floating form.
4. T. S. of floating form.
5. A portion of T. S. of land form.

RICCIA MELANOSPORA. 6—7.

6. Two plants.
7. T. S. of thallus.

FAMILY III. RICCIACEAE.

Chlorophyll-bearing layer with narrow air-spaces or with larger chambers. Pores absent or rudimentary. Archegonia immersed singly in cavities on the dorsal surface. Sporogonium without a foot or seta and remaining enclosed in the calyptra, dehiscing by the decay of the capsule wall; sterile cells absent.

Epidermis without pores; antheridia scattered in the thallus .... *Riccia.*
Epidermis with distinct minute pores, antheridia aggregated in a median furrow of the thallus .... *Ricciocarpus.*

XXIII. RICCIOCARPUS corda.

Ricciocarpus Corda in Opiz. Beitr. p. 651 (1829).

Plants thallose thick. cavernous, dichotomously branched, with obcordate lobes, rarely forming rosettes, floating in water and then sterile, or fruiting on mud. Chlorophyll-free layer very weakly developed, the thallus consisting for the greater part of polyhedral air-chambers; the dorsal epidermis with pores. Ventral surface with long, dentate, violet-coloured scales. Antheridia in a long definite cushion in the median furrow on the dorsal side. Archegonia in rows, each surrounded by a rudimentary cup-shaped involucre. Capsule immersed. in the tissue of the thallus.

49. Ricciocarpus natans corda.

Ricciocarpus natans Corda in Opiz, Beitr. p. 651 (1829).

Dioecious. Dimorphic. Floating form sterile; fixed form fertile.

Floating form:—Very much like *Lemna*, with broadly obovate lobes more or less violet, with long, pendent, serrated, violet scales on the ventral surface, and with a few smooth rhizoids or none.

Terrestrial form:—Caespitose. Thallus forming semirosettes 10 to 12 mm. in diam., once or twice dichotomously divided. Lobes obcordate or broadly linear, 2 mm. broad, notched at the apex. Dorsal surface with a distinct furrow. Air-chambers large, with one-layered walls. Pores bounded by 6 to 8 cells with slightly thickened walls. Ventral surface with usually violet dentate scales and purple smooth rhizoids. Cross section nearly flat, becoming thinner towards the margin, slightly convex on the ventral surface. Capsules singly or in pairs, in rows, in the centre of the thallus. Spores 51 μ, reticulate, reticulations sometimes imperfect, margin narrowly winged, escaping through a slit along the median furrow of the thallus.

Hab.	Floating on water or rooted on mud.
Distrib.	Kashmir, the *Dal Lake* (Sahni); *Peshawar* (N. A. Qizilbash).

Note.—The specimens in my collection are all sterile. The description of fertile plants is after Macvicar, "Students' Handbook of British Hepatics."

* * * * *

XXIV. RICCIA L.

Riccia L., Sp. Pl. p. 1138 (1753).

Monoecious or dioecious. Thallus dichotomously branched, with linear to obcordate segments, terrestrial or more rarely floating on water. Dorsal surface usually green, generally with a distinct median furrow; margin occasionally with cilia. Chlorophyll-bearing layer with narrow and deep air-spaces, or with large chambers opening by their whole width. Ventral scales usually in one row at the apex, but later, through rupturing in the median line, apparently 2-rowed, well developed, rudimentary or sometimes absent, hyaline or coloured. Rhizoids usually of two kinds, smooth and tuberculate, sometimes only smooth, and in *Riccia fluitans* (floating form) absent. Antheridia and archegonia scattered singly on the dorsal surface, immersed at maturity in the chlorophyllaceous tissue. Involucre none. Ostioles of the antheridial chambers usually below the epidermis, though in some cases long and prominent. Archegonia usually purple at the tip, neck occasionally projecting.

Capsule sessile, immersed in the midrib, without a foot and a seta. Calyptra persistent. Spores included, large, tetrahedral.

Note :—The genus *Riccia* may be derived from a genus like *Targionia*, in which the vegetative tissue of the thallus has still further increased at the expense of the sex organs as given under the genera~~s~~ *Targionia* and *Cyathodium*. Lang has found that in *Cyathodium cavernarum* the archegonia lie actually on the upper surface within the valves of the involucre, the growing point being right at the apex in front. If this growth of the apex is continued forwards and the valves of the involucre are further reduced in size, a condition resembling the one found in some *Riccias* would be arrived at. In the male shoots of *Targionia* the receptacle has well- developed air-chambers between the antheridial chambers, and if similar chambers are developed in between the archegonia in the above mentioned case we would have a plant resembling *R. pathankotensis* which has a broad channel on the dorsal surface. By the further reduction of the ridges of the dorsal channel the last and the simplest condition is reached, as seen in *R. sanguinea* in which there is often no trace of the dorsal furrow, and further there are no scales and tuberculate rhizoids.

It should, however, be borne in mind that some species of the genus *Riccia* (specially the sub-genus *Ricciella*) may have arisen by reduction from types like *Boschia* and *Corsinia*. The species generally referred to the genus *Riccia* seem to have arisen along more than one line. This genus, therefore, is the last term in a long series of forms and not the first term in an ascending series.

Key to the species.

1 Plants aquatic .... *R. fluitans.*
Plants on moist or dry soil, never aquatic 2

2 Air-spaces wide, sporogonia prominent on the ventral side 3
Air-spaces narrow, sporogonia prominent on the dorsal side 4

3 Plants thin, delicate, usually cruciate in form, spores 60 μ .... *R. cruciata.*
Plants thick, robust, spores 80 μ .... *R. robusta.*

4 Dioecious, male plants red, scales absent .... *R. sanguinea.*
Monoecious, scales present 5

5 Scales bent over the margin .... *R. himalayensis.*
Scales not bent over the margin 6

6 Dorsal surface with a distinct broad channel, spores reticulate .... *R. pathankotensis.*
Dorsal surface with a narrow furrow near the apex, spores perfectly opaque .... *R. melanospora.*

50. **Riccia pathankotensis** Kashyap.

Riccia pathankotensis Kashyap. Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 349 (1916).

Monoecious. Plants overlapping in dense patches, occasionally singly and spreading when on open space. Thallus once or twice forked, compact, light green, up to 5 mm. long ; lobes oblong, obtuse, 2-3 mm. long and 1 mm. broad. Cross section oblong, twice as broad as high. Dorsal surface with a broad median channel. Air-spaces narrow. Wings thick. Cilia usually present on the margins and occasionally also on the dorsal surface. Epidermal cells hyaline, spherical. Ventral surface hyaline or blackish, broad, flat or slightly convex. Scales small and hyaline, almost overlapping, not projecting beyond the margins. Antheridia globular, or slightly elliptic, papillae slightly projecting, hyaline, in 2 or 3 rows, in the channel. Capsules also in the channel in 2 or 3 rows, with very little vegetative tissue between them, visible from the dorsal side. Spores tetrahedral, reticulate, with 8 areoles in the diameter, papillose in profile, margin slightly and irregularly crenate, 95 μ in diam.

Hab On the banks of streams and other moist places.

Distrib. *Pathankot, Lahore*; Kulu, *Manali.*

Note :—This species can be readily distinguished from the other species of the genus, by the broad channel on the dorsal surface. The capsules occur in groups. Sometimes as many as six are found together touching each other without any green tissue between them, the small amount which was present in the beginning having been disorganised.

PLATE XX.

RICCIA PATHANKOTENSIS. 1—4.

1. A patch of plants.
2. Three plants showing habit.
3. T. S. of thallus.
4. A spore.

RICCIA HIMALAYENSIS. 5—9.

5. A patch of plants.
6. A plant.
7. T. S. of thallus.
8. T. S. of fungus-infected thallus. Note the perithecia with projecting necks.
9. A spore.

RICCIA ROBUSTA. 10—12.

10. Two plants.
11. Three T. S. of thallus from various plants.
12. A spore.

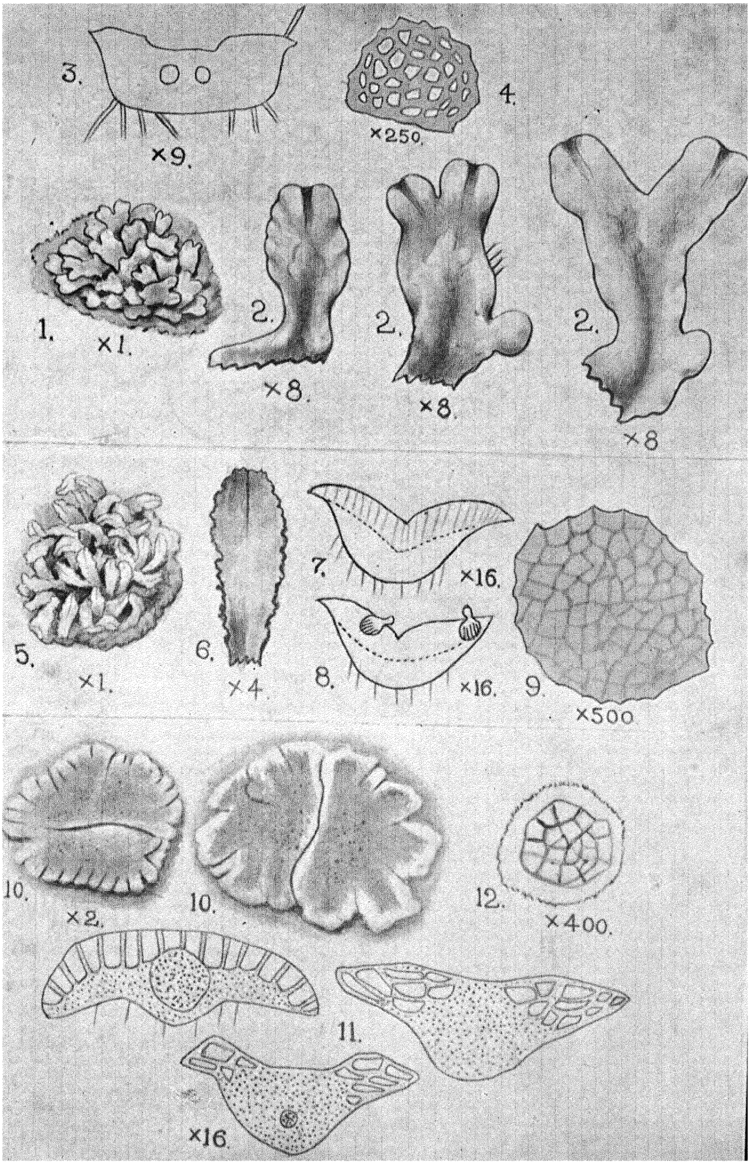

PLATE XX.

51. Riccia himalayensis St. (Ms.).

Riccia himalayensis St. (Ms.), Kashyap in Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 349 (1916).

Dioecious. Plants once or twice forked, compact, closely creeping, up to 5 mm. long and 1-2 mm broad ; lobes linear or oblong. Dorsal surface green, with a narrow median sulcus. Air-spaces narrow, slit-like. Epidermal cells hyaline, thin-walled, mammillate. Ventral surface purple, midrib convex, projecting downwards. Cross section 3 times as broad as high. Margins often purple, entire, bent downwards. Scales small, semilunar, distant, purple or hyaline, bent over the margin. Antheridia in one median row, papillae long, red, projecting, conspicuous. Capsules in a single median row, spores coming out by the rupture of the dorsal tissue. Spores tetrahedral, finely reticulate, 9-10 reticulations in the diameter, margin narrow, entire, maximum diameter 100 μ

Hab. Moist soil.

Distrib. Common in the Himalayas from the foot to an altitude of 9,000 feet in Lahul, sometimes coming down to the plains, Lahul, *Salgraon* : *Lahore, Pathankot* : Kulu; *Simla*; *Mussoorie*; etc., Tinnevelly Hills (Rangachariar) ; *Calcutta. Darjeeling* (Tirunarayanan) : *Rangoon* (Ghose).

Note :—The apex at the end of the season grows down into the soil and becomes thick. Next season it grows up and gives rise to a new plant. Some plants were once found attacked by an ascomycetous fungus which formed sunken perithecia with necks projecting on the dorsal surface. These could easily be mistaken for capsules. The perithecia were full of asci each containing 2-celled spores. This is the only liverwort, so far as I know, found attacked by an ascomycetous fungus bearing perithecia. Some specimens from Dehra dun have long narrow lobes, 2 mm long and 1 mm. broad.

This species often occurs with another form, seen only in the sterile condition, which is much smaller and distinctly blue in colour. Otherwise the latter is similar to the above. It is perhaps the young condition of *Riccia himalayensis* fixed under some unknown condition or possibly a different species.

52. **Riccia melanospora** Kashyap N. S.

Monoecious. Plants small, dichotomous, in patches; lobes oblong-obovate, up to 2 mm. long and 1 mm. broad. Dorsal surface green or greyish green, with a deep narrow sulcus near the apex, and broad flat or slightly concave in the posterior part. Air-spaces narrow, slit-like. Epidermal cells rounded, hyaline. Ventral surface hyaline in the middle, purple below the wings: midrib projecting ventrally, gradually passing into the thick margins. Margins purplish or black, appressed to the substratum. Cross section semicircular, about twice as broad as high. Scales small, purple, confined to below the apex, absent everywhere else. Rhizoids mostly smooth, a few tuberculate. Antheridia in a middorsal row. Sporogonia prominent on the dorsal side, dehiscing by decay of the dorsal tissue. Spores perfectly opaque, black, 80 µ.

Hab. On moist soil.

Distrib. *Hoshiarpur* (B. R. Vasisht).

53. **Riccia robusta** Kashyap.

Riccia robusta Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 348 (1916).

Monoecious. Thallus very spongy, of a yellowish green colour, forming rosettes up to 15 mm. in diameter, plants sometimes small and overlapping, lobes spreading, up to 2 mm. broad. Dorsal surface flat, margins often turned upwards, specially before dichotomy, often with a fairly broad median groove; occasionally in closely creeping plants the margins are firmly bent downward. Air-chambers large, opening by large indefinite pores, the large pits on the posterior part being quite visible to the naked eye. Ventral surface greenish, midrib strongly projecting; scales none. Antheridial papillae not distinct. Capsules project ventrally. Spores tetrahedral, brown when young, quite opaque (black) at maturity, reticulate, reticulations clear in young condition, 4 or 5 large reticulations in the diameter, often each reticulation again divided into two or more smaller ones; wing usually broad and finely dentate, sometimes narrow or even absent; up to 80 µ in diameter, often much smaller.

Hab. Moist places.
Distrib. *Lahore*, Shalamar Gardens, Ravi banks: *Lucknow* (S. K. Pande): *Banda*, banks of the Ken; Lahul above *Kyelang*, 11,000 feet Spiti 13,000 feet *Indore* (T. C. N. Singh).

Note:—The plant grows on the river banks at Lahore, also in the cracks between the bricks of the floor in the Shalamar Garden, Lahore, during winter. It has a very wide range: 700 feet in Lahore to 13,000 feet in Spiti. Plants from Lucknow have practically no wing or a very narrow one on the margin of the spore and the reticulations are 6-7 in the diameter, many of them incomplete. Mr. S. K. Pande informs me that he has seen very small rudimentary scales at the apex. Lahul specimens have no tuberculate rhizoids, only rarely a rhizoid shows a tubercle at long intervals: spores are not quite opaque and are rather smaller, about 70 µ. Plants from Lahul and Spiti are very small, densely overlapping, rosettes often incomplete, usually less than 12 mm. in diameter, resembling the young plants found in the beginning of the winter in Lahore.

The thick thallus and the spongy texture with the wide pits visible to the naked eye in the posterior part on the dorsal surface distinguish this species from the rest.

54. **Riccia cruciata** Kashyap.

Riccia cruciata Kashyap, Jour. Bom Nat. Hist. Soc. Vol XXIV, p. 349 (1916).

Monoecious. Thallus yellowish green, spongy, thin, delicate, usually twice forked, with divergent lobes, thus forming as a rule a cruciform rosette, about 10 mm. in diam., lobes obovate-oblong with a shallow narrow median sulcus. Cross section oblong, 4 or 5 times as broad as high, both surfaces flat, chambers large, epidermis thin, hyaline. Scales small, delicate, fugacious, often only as small oblique ridges or absent. Rhizoids chiefly smooth, a few tuberculate. Antheridia globular, papillae inconspicuous. Capsules projecting ventrally. Spores tetrahedral, completely reticulate, 60 µ in diam.

Hab. Moist beds in gardens; river banks.
Distrib *Lahore*, Ravi banks, Lawrence Gardens; *Banda*, banks of the Ken.

Note:—*Riccia robusta*, *R. cruciata* and *R. sanguinea* very often occur together during winter in the plains. *R. cruciata*, however, is rather rare.

55. **Riccia sanguinea** Kashyap.

Riccia sanguinea Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 349 (1916).

Dioecious. Male plants minute, red, linear or once or twice forked, or forming red or greenish-red rosettes (always smaller than the female rosettes), papillae red, conspicuous. Female plants usually in large compact green rosettes, often overlapping in large clusters; rosettes 15 mm. in diam., lobes linear-oblong to obovate-oblong, parallel, closely attached to the substratum. Dorsal surface flat or slightly convex, occasionally with a narrow middorsal groove. Thallus compact. Air-chambers narrow, slit-like. Epidermis of a single layer of cells, cells hyaline, thin-walled. Cross section elliptic or semicircular; midrib gradually passing into the obtuse margins; wings practically absent. Scales absent Rhizoids only smooth, rarely a few with faint tubercles. Antheridia oblong, cylindrical, in 1 or 2 rows; papillae red, projecting, conspicuous. Archegonia usually indicated in the young stage by red dots on the dorsal side, neck not projecting. Capsules in 1 median row on each lobe, distant, dehiscing by the rupture of the dorsal tissue. Spores opaque, tetrahedral, granular or with very close, irregular, almost wavy streaks, 50 µ in diam.

Hab. On banks of streams.

Distrib. *Lahore*, Ravi banks; banks of the Son (Baini Prashad): *Banda*, banks of the Ken: *Allahabad* (Dudgeon); *Coimbatore* (Rangachariar); Assam, *Manipur* (S. L. Hora); *Peshawar* (N. A. Qizilbash).

Note:—The plant is very widely distributed in the plains in India, especially on the banks of rivers. Fully developed plants form circular rosettes, male red and female green. The absence of scales, of the tuberculate rhizoids and often of the dorsal groove, and the very small size, without branching in many cases, all indicate that the species is the simplest

Plate XXI.

RICCIA CRUCIATA. 1—5.

1. A patch of plants.
2. A single plant.
3. T. S. of thallus.
4. A portion of above, magnified.
5. Three spores.

RICCIA SANGUINEA. 6—9.

6. A male plant.
7. A female plant.
8. T. S. of thallus. The upper figure shows a capsule.
9. Two spores.

RICCIA FLUITANS. 10—13.

10. Floating form.
11. Land form. Note projecting sporogonium.
12. T. S. of thallus.
13. A spore.

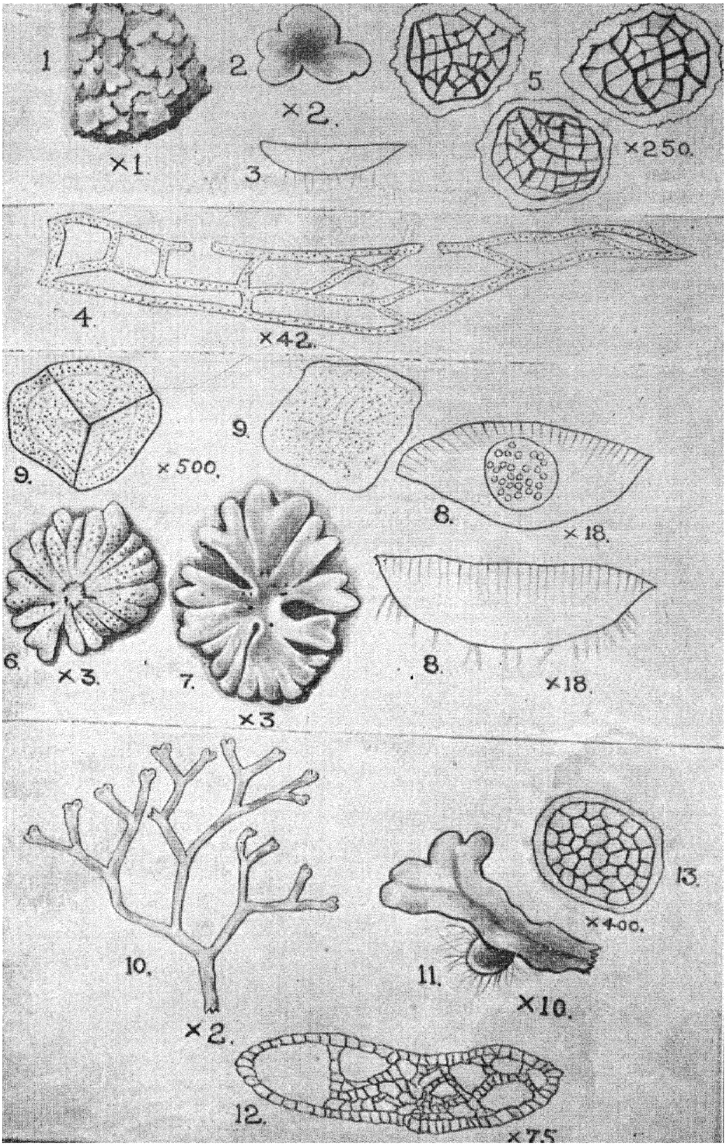

PLATE XXIV

in the genus *Riccia,* and, therefore, the simplest of the *Marchantiales.* Perhaps identical with *Riccia Frostii* Austin.

56. **Riccia fluitans** L.

Riccia fluitans L., Sp. Pl. 1139 (1753).

Monoecious. In sterile patches floating on stagnant or slowly moving water, yellowish green. Thallus 30-50 mm. long and 1 mm. broad, several times dichotomously branched ; segments divergent, linear, apex emarginate or truncate; thin, with a groove near the apex, flat, yellowish green on both surfaces, no scales or rhizoids on the ventral side. Cross section almost flat, margin obtuse, air-chambers large, in several layers. Terrestrial form thick, broadly channelled, occasionally tinted with violet on the sides and margin; rhizoids numerous ; ventral scales small, confined to near the apex, colourless or violet. Cross section semilunar, margin obtuse. Air-chambers large in several layers. Capsule forming a spherical protuberance on the ventral side, furnished with rhizoids on the enclosing tissue. Spores brownish-yellow, translucent, 75-90 μ in diam.; margin broad, 4-7 μ across, entire or nearly so; face with 4 or 5 areolae across the diameter, those in the centre large.

Hab.	Stagnant or slowly moving water, or banks of streams.
Distrib.	Garhwal, Jumna valley ; Kashmir : *Peshawar* (N. A. Qizilbash); *Madras,* (Iyenger).

Note :—*Fysonia tenera* Kashyap from South India is merely a form of this species. The "foot" of that plant, the chief character in which it differs from the present species, is no doubt a group of cells of the thallus, more or less modified on account of the proximity of the capsule.

ORDER III.

JUNGERMANNIALES.

Gametophyte an undifferentiated thallus or differentiated into stem and leaves, with little histological differentiation. Scales usually absent. Rhizoids always smooth. Sex organs usually arranged in groups but never raised on stalked receptacles, occasionally immersed in cavities. Sporogonium with a foot and seta. Capsule wall two or more cells in thickness. Elaters present. Dehiscence usually by 4 valves.

FAMILY IV. CODONIACEAE.

Thallose foliose or forms intermediate between them. In the foliose forms leaves in two rows, parallel to the stem or obliquely inserted and succubous, simple. Rhizoids always present. Male and female inflorescences scattered on the dorsal side or in groups. Archegonial cluster surrounded by an involucre and in the genus *Calycularia* by an additional perianth also. Capsule usually with a long seta, globose (oval in *Blasia*), dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells (four in *Blasia*, *Treubia*), well-developed fibrous bands being usually present on either the outer or the inner cells, or on both. Elaters adherent to the base or apex of the capsule or partly free, more rarely altogether free, 2-4-spiral.

XXV. FOSSOMBRONIA Raddi.

Fossombronia Raddi, in Atti Soc. Ital. Mod. 18 (1818).

Stem creeping, simple or dichotomously branched, flattened above and strongly arched below, with long, mostly violet-coloured smooth rhizoids. Leaves green, in 2 rows, succubous, obliquely inserted and decurrent, generally broader than long, with irregularly sinuate and usually lobed margin, base more than one cell thick, rest 1-layered, cells large, thin-walled. Antheridia orange-yellow, accompanied by bracts, on the dorsal surface of the stem near the insertion of the leaves. Archegonia in a group on the dorsal surface of the stem towards the apex at the base of the leaves, becoming enclosed in a large campanulate perianth. Perianth. with a wide lobed mouth and narrow base, often longitudinally plicate, frequently incised to the base. Calyptra pyriform, thick at the base. Capsule shortly pedicellate, globose, dehiscing irregularly or imperfectly by 4-valves. Wall of two layers of cells. the inner layer with frequently incomplete bands. Spores large. rounded, tetrahedral. Elaters short, bi- or tri-spiral.

57. **Fossombronia himalayensis** Kashyap.

Fossombronia himalayensis Kashyap. New Phyt. Vol. XIV, p. 4 (1915).
Fossombronia Levieri St., Sp. Hep. Vol. VI, p. 74 (1917).

Monoecious or dioecious. Plants caespitose among grass or moss or singly on moist rocks; small and compact in former places but open and longer in latter places; two or three times branched, branches up to 6 mm. long. Rhizoids usually violet, sometimes hyaline. Leaves oblong, wavy, ascending, overlapping to about 1/3 of the length; outer margin irregularly and indistinctly toothed. Perianth with wavy margin, sometimes split to the base along one side. Seta up to 5 mm. long, often very short; capsule usually exserted. Cells of the outer layer of the capsule wall with thin walls those of the inner layer with U-shaped bands on the inner and radial walls near the apex, but only simple bands on radial walls at other places. Dehiscence by separation of the apical portion. Spores with furcate high lamellae, sometimes forming a few reticulations, 40 to 50 μ in diam. Elaters laxly bi- or tri-spiral, 100 to 140 μ long.

Hab. Moist rocks or among grass and moss.

Distrib. Common. Outer Himalayas, Ravi valley, *Simla*, etc.; Kumaon, *Mussoorie*, etc. 5,000 to 7,000 ft. *Lahore*, rare. South India, Nilgiris (Rangachariar); Bombay, *Panchgani* (Blatter).

Note:—Towards the end of the season the apex of the plants ceases to form the leaves, bends downwards and becomes thickened. These apical tubers are thus borne on cylindrical stalks and remain buried in the ground during winter. They grow out into new plants next spring.

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XXVI. SEWARDIELLA Kashyap.

Sewardiella Kashyap, New Phyt. Vol. XIV, p. 5 (1915).

Dioecious. Plants thallose, simple or forked, occurring in thick patches on rocks or singly among grass and moss in shady places. Thallus winged, wings attenuated, directed upwards. Dorsal surface concave. Midrib thick, projecting ventrally, flat above and rounded below. Ventral surface usually with minute red scales in two rows. Wings many-layered at the base, gradually becoming thin, and 1-layered throughout the greater portion, ascending, margin wavy. Male and female plants similar. Antheridia in a cluster on the dorsal side of the midrib mingled with a few bracts. Archegonia in a cluster on the dorsal side. Perianth bell-shaped, margin lacerated into numerous processes, often split at one or more places up to the base, many-layered at the base, 1-layered above. Calyptra thin, 1-layered. Sporogonia 1 or more in each perianth ; foot small; capsule included or slightly exserted. Capsule wall 2-3-layered ; inner layer with thick bands. Spores reticulate-lamellate. Elaters bi- or tri-spiral ; no fixed elater-like cells anywhere in the capsule.

58. **Sewardiella tuberifera** Kashyap.

Sewardiella tuberifera Kashyap, New Phyt. Vol. XIV, p. 5 (1915).

Dioecious. Thallus up to 10 mm. long and 12 mm. broad, often once forked, arising from a thick base and ending in a wingless stalked tuber at the apex, the apical wingless portion often forked, midrib mycorrhizal, thick, projecting ventrally, rounded below. Ventral surface usually with minute red scales in two rows. Wings often unequal, many-layered at the base, gradually becoming thin, one-layered throughout the greater portion, ascending, margin wavy ; upper surface of the thallus concave. Antheridia on the midrib, each antheridium globular, on a short stalk ; bracts few, scattered between the antheridia. Perianth bell-shaped, margin lacerated into numerous narrow processes; calyptra thin, 1-layered. Sporogonia 1-3, sometimes more, in each perianth; foot small; seta up to 1·25 mm. long, capsule 1 to 1·3 mm. in diameter, included or slightly exserted. Capsule wall 2-3-layered; the cells of the outer layer usually thin-walled, sometimes with thick bands on the radial walls; cells of the inner layer with U-shaped bands on inner and radial walls or only simple bands on the radial walls. Spores reticulate-lamellate, less than 4 reticulations in the diameter, 40 μ. Elaters bi- or tri-spiral, 300 to 400 μ; no fixed elaters at the base or elsewhere.

Hab. In large patches on moist rocks, occasionally singly among moss or grass.

Distrib. Common at 5,000 to 7,000 feet *Mussoorie*, *Simla* etc.

Note :—Towards the end of the season the plant forms apical tubers like *Fossombronia tuberifera*. The thick tubers are borne on cylindrical stalks, are covered by small red scales and remain buried in the soil during winter. When the tubers germinate next year the scales are carried on the under surface of the plants but are naturally restricted mostly to the posterior part of the plant. The tuber-bearing portion often forks and sometimes the whole plant is forked, each branch bearing a tuber at the apex.

The plant is closely allied to *Fossombronia tuberifera* not only as regards tuber-forming habit but in the position of the sex organs, the perianth and the structure of the sporogonium. As a matter of fact, the only difference between the two genera is that, whereas, in *Fossombronia* the wing is divided into lobes (leaves), in *Sewardiella* it is entire. The plant may well be put in the genus *Fossombronia* if the same procedure is followed in the other *Anacrogynous Jungermanniales*, and the difference between an entire and a lobed wing (leafy stem) is not considered to amount to a generic difference.

The plant can be easily recognised by its saddle-shaped thallus raised up in the middle and bent down both anteriorly and posteriorly, and ascending wings. From the apical tuber, which lies buried underground, the plant on germination begins to grow upwards, then grows horizontally for a short distance and bends down again to form a new tuber. The midrib in this way forms a characteristic bend with the concavity downwards. Several such bends may be met with in the same plant behind one another indicating several years' growth, but the wing, naturally, disappears in the older parts.

In the young condition the plant is exceedingly like the tuberous prothallus of *Gymnogramme leptophylla*, a fern, which is sometimes met with in the localities where this plant grows.

The perianth arises in the form of several bracts, which do not grow simultaneously. Gradually the bracts fuse and all of them are then carried upwards by basal growth. Sometimes fusion can not take place at one or two places, the bracts being at a distance from each other. In such cases the perianth shows one or two splits extending to the base. As the bracts do not arise in a regular ring but some towards the outside and others towards the centre nearer the archegonia we find that in the ripe perianth these may be fused to both the inner and the outer surface of the perianth. Sometimes the number of these bracts is so great that the perianth has the appearance of a double flower.

The morphology of the involucre and the perianth in the *Codoniaceae* requires further investigation. As pointed out above, in the genus *Sewardiella* in the young condition, the archegonia are surrounded by a number of bracts, and these later on, by basal zonal growth, are carried upwards and a more or less bell-shaped structure is produced which has got these bracts on the margin or on the sides. The whole structure may as well be called an involucre. The time of formation does not seem to be a sufficiently important character to make a distinction between the involucre and the perianth.

* * * * *

XXVII. PETALOPHYLLUM Gottsche.

Petalophyllum. Gottsche in Lehm. Pug. Pl. VIII. P. 29 (1844).

Plants small and slender with a short basal cylindrical stalk-like portion and a fan-like expansion, simple or furcate, with parallel erect lamellae on the dorsal surface. Antheridia scatter-

PLATE XXII.

PETALOPHYLLUM INDICUM. 1—5.

1. A male plant.
2. A female plant.
3. Perianth with the sporogonium.
4. An elater.
5. Two spores.

SEWARDIELLA TUBERIFERA. 6—10.

6. A forked male plant from above (left), and from below (right). Note tubers in the latter.
7. Female plants. In the specimen to the left the wing has been removed on one side to show the sporogonia Note the bends in the stem indicating the growth of several years.
8. A perianth cut open.
9. A spore. 10. An elater.

FOSSOMBRONIA HIMALAYENSIS. 11—15.

11. A male plant.
12. Two female plants. In the specimen to the right the characteristic bend in the stem and the a tuber.
13. A spore.
14. An elater.
15. Portion of the capsule wall.

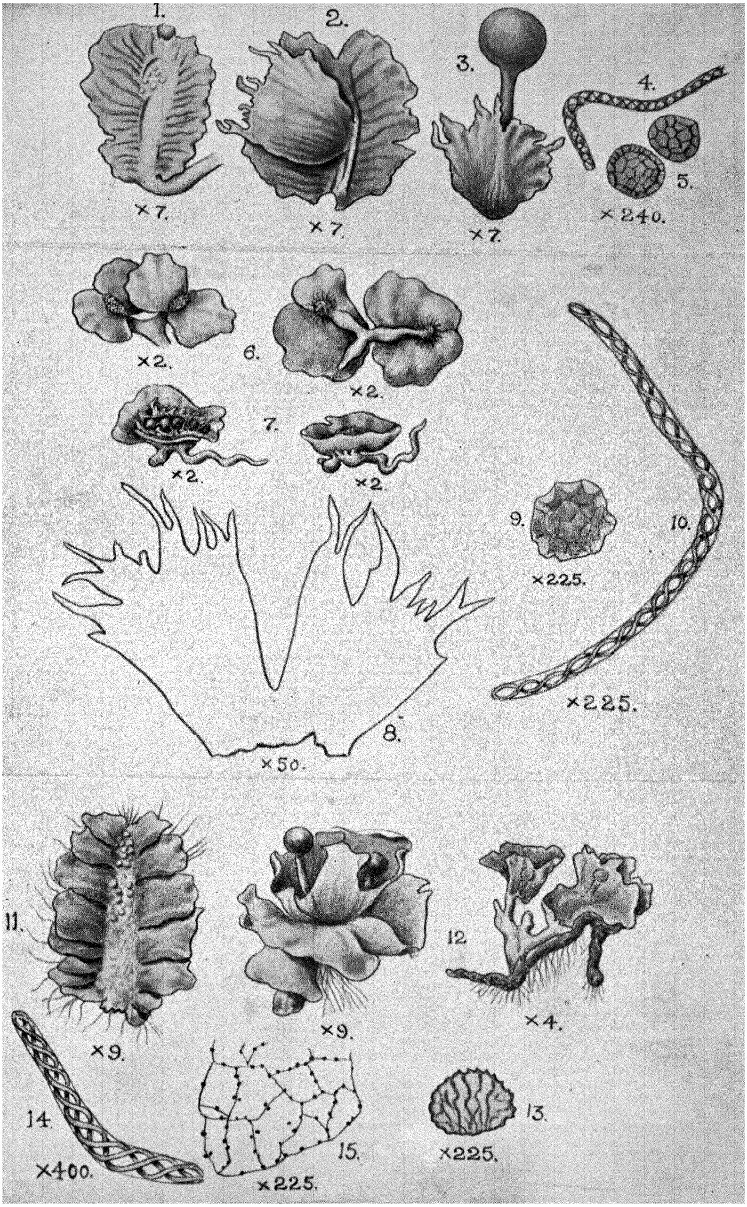
1.
×7.
2.
×7.
3.
×7.
4.
5.
×240.
×2.
6.
×2.
7.
×2.
×2.
9.
×225.
10.
×225.
8.
×50.
11.
×9.
×9.
12
×4.
14.
×400.
15.
×225.
13.
×225.

PLATE XXIII.

ed on the dorsal surface, spherical with a short pedicel, accompanied by scales. Archegonia in groups on the dorsal surface, surrounded by scales, and enclosed at maturity by the tubular perianth. Calyptra free, large. Capsule rather shortly pedicellate, spherical, dehiscing irregularly. Wall of 3 or 4 layers of cells, the inner with incomplete annular bands. Spores reticulate-lamellate Elaters long, more or less attenuate, 2-3-spiral.

59. **Petalophyllum indicum** Kashyap.

Petalophyllum indicum Kashyap, Jour. Ind. Bot. Soc. Vol. VII, p. 14 (1928).

Dioecious. Plants simple or furcate, growing singly or in patches of 3 or 4, up to 12 mm. long and 7 mm. broad. Basal portion cylindrical and wingless. Wing many-layered at the base, gradually becoming one-layered, wavy along the margin. Lamellae one-cell thick and 15 to 24 cells high, running outwards and forwards from the midrib, not always parallel. Antheridia in groups behind the apex, protected by scattered scales. Archegonia in groups of 4-7 on the midrib, protected by a bell-shaped perianth with a lacerated margin, often with 2 or 3 splits along the whole length. Sporogonia 1-4, usually one, in each perianth. Seta usually 10 to 20 mm. long, sometimes very short, occasionally up to 25 mm. Capsule 2 mm. in diameter, spherical, dark brown. Capsule wall usually 3-layered; cells of the outer layer thin-walled, sometimes with thick radial walls; those of the inner layers with thick annular or sometimes semi-annular bands. Spores dark brown, about 40 µ in diameter, spherical, with a membranous wavy margin reticulate-lamellate, 3-4 reticulations in the diameter, reticulations pentagonal or hexagonal, 8-10 µ, marginal wing 14-17 µ. Elaters trispiral, lightly coloured, spirals very distinct, brown and lax, 280-400 µ long, 8-10 µ broad, simple or occasionally branched, attenuated towards both ends. A few elaters are short and about 16 µ broad.

Hab. Moist places.

Distrib. *Lahore*, Ravi banks.

Note.—At the end of the season the apex becomes thickened, forming a tuber, and becomes buried underground. The dorsal vertical lamellae easily distinguish this plant from other liverworts.

* * * * *

XXVIII. BLASIA L.

Blasia L., Sp. Pl. p. 1138 (1753).

Thallus several times dichotomously branched, with a broad midrib passing into 1-layered lobes (leaves). Under-leaves in one row on each side of the midrib. Leaf-auricles containing *Nostoc* colonies present at the base of the lobes usually in pairs. Male plants smaller, antheridia oval, with a short pedicel, immersed singly in small chambers. Archegonia at first naked, after fertilisation becoming enclosed by a fusiform thick involucre with a constricted mammillate apex. Calyptra free, thin and membranous. Capsule rather longly pedicellate, oval, with a collar at the base. Dehiscence by 4, rarely 5-6 valves. Capsule wall of 3-4 layers of cells, those of the outer layer with thick radial walls, those of the inner layers smaller and tender without bands and soon becoming disorganised. Elaters bispiral, spirals often splitting. A few rudimentary elaters fixed at the base of the capsule. Gemmae of two kinds.

60. **Blasia pusilla** L.

Blasia pusilla L., Sp. Pl. p. 1138 (1753).

Dioecious. Plants rather fleshy, dichotomously branched, lobed, lobes (leaves) rather shallow not extending to the midrib, very leaf-like at the apex. Thallus up to 30 mm. long and up to 5 mm. broad. Midrib broad, projecting ventrally, gradually passing into the wings, about 10 cells thick in the middle. Upper and lower epidermal cells small, middle ones large. Under-leaves in two rows, one on each side of the midrib, distant, small, hyaline, ovate to subrotund, irregularly toothed, peltate. *Nostoc* auricles usually two at the base of each lobe. *Nostoc* colonies rounded or oval, seen from the dorsal side through the thallus, appearing as if embedded in the thallus. Star-shaped gemmae generally present behind the apex, easily detached and scattered. Flask-shaped gemmae receptacles rare. Male plants smaller, antheridia few, oval. Pedicel of the capsule 2 cm. long. Spores 33-43 μ, rounded, yellowish brown, granular. Elaters paler in colour, about 27 μ long.

Hab. Moist rocks.

Distrib. Kulu (6,000 ft.), *Nagar*, *Karaon*; Garhwal, Gangotri Road.

Note.—The sterile plants resemble *Anthoceros* superficially, especially on account of the *Nostoc* colonies. They can be easily distinguished by the star-shaped gemmae on the dorsal surface, just behind the apex, which are almost always present.

The plant is intermediate between the thallose and the foliose forms. The lobes in the posterior part are quite shallow, but at the apex they are very leaf-like. They are regarded as lobes or leaves variously by different writers. In addition to these lobes the plant has other appendages on both the ventral and dorsal surface. On the ventral surface are the underleaves and *Nostoc* auricles. On the dorsal surface are found two kinds of gemmae. Just behind the apex naked star-shaped gemmae are met with in almost all plants. These scale-like gemmae are met with loosely attached singly to the dorsal surface behind the apex and are attached at the base, unlike the amphigastria which they resemble in shape but which are peltate. The gemmae begin to grow while still attached to the plant and are usually detached in the form of a tuft. They are easily detached and are seen scattered on the dorsal surface. Other gemmae are met with in flask-like cavities on the dorsal side. Sometimes archegonia occur in these receptacles along with the gemmae.

I have so far come across no ripe sporogonia and the description of the sporogonium is after Macvicar and Stephani.

* * * * *

XXIX. PELLIA Raddi.

Pellia Raddi, Mem. Soc. Ital. Mod. 18 p. 49 (1820).

Thallus thin, prostrate, dichotomously branched, with a broad midrib, slightly projecting below, gradually passing into the wings; wing many-layered towards the midrib, becoming 1-layered towards the margins. Internal cells wider than the epidermal cells. Scales absent; club-shaped mucilage hairs present at the apex. Antheridia globular, shortly stalked, immersed singly in the cavities on the dorsal side of the midrib in 2 to several rows. Archegonia on the dorsal surface of the thallus in a pit surrounded by a complete or incomplete (open in front) tubular involucre, capsule with a long seta, globular, wall 2 or more cells thick, dehiscing by 4 valves up to the base. Spores large, germinating within the capsule. Elaters 2- or 3-spiral, many fixed to the base of the capsule.

Note.—The Himalayan *Pellias* require further observations. All the three species of the genus are said to occur in the Himalayas. Unfortunately fertile plants with ripe sporogonia are rarely met with. *P. calycina* as described here is exceedingly common throughout the Western and the Kumaon Himalayas from 5,000 to 8,000 feet. What looks like *P. epiphylla* has been met with occasionally, but I have not come across specimens, which could be certainly referred to *P. Neesiana.*

Note.—Stephani does not mention the presence or absence of fibrous bands as a distinguishing feature of the species. All the specimens described here under *Pellia calycina* are without such fibres, though the involucre in these forms is more like that described by others for *P. Neesiana.*

Key to the species (after Macvicar)

1 Thallus without fibrous bands on the cells as seen in cross section of the thallus .... *P. calycina.*
Thallus with brown bands, calyptra exserted, inner wall of the capsule with bands 2

2 Monoecious; involucre hood-like posteriorly, wanting in front .... *P. epiphylla.*
Dioecious; involucre complete, tubular .... *P. Neesiana.*

61. **Pellia calycina** (Tayl.) Nees.

Pellia calycina Nees, Hep. Eur. III p. 386 (1838).
Pellia Fabbroniana Raddi Mem. Soc. Ital. Scient. Mod. 18 p. 49 (1818).

Dioecious. Plants green, growing among moss and grass, or in dense patches of overlapping individuals under flowing water, dichotomously or more or less pinnately divided, lobes quadrate to oblong-linear, about 5 mm. broad, often with a dark streak along the middorsal line, margin undulate, apex slightly notched. Midrib conspicuous, slightly projecting ventrally, gradually passing into the many-celled lamina, which becomes one-layered towards the margin, one-celled portion from a few to 15 cells broad, greatest thickness in the middle about 10 cells, no thickened bands on the cells. Antheridia conspicuous, in 2 or 3 rows on the dorsal side of the midrib. Archegonia in a cluster. Involucre tubular, directed forwards, posterior wall long, anterior short, mouth shortly irregularly dentate. Calyptra included. Rest not seen.

Hab. On moist soil among moss and grass, or actually under flowing water.

Distrib. Exceedingly common in the Kumaon and the Western Himalayas, becoming less frequent to the west up to Kashmir; 5,000 to 8,000 feet. *Mussoorie*; Kulu; *Simla*; *Dalhousie;* Pangi; *Murree;* Jummu, *Patni Pass*; *Verinag;* Kaghan valley (N. A. Qizilbash), etc.

Note.—The plant forms large patches of overlapping individuals under flowing water, usually accompanied by *Dumortiera hirsuta*, and often by *Conocephalum conicum.* It can easily be recognised from the former by its smaller size and lighter colour and from the latter by the absence of reticulations, pores and scales. It varies greatly in length, breadth and thickness of the lobes. In very moist and shady places the lobes are long, narrow and thin; in other places they are broader and thicker, with a conspicuous dark middorsal streak. During the growing season the plants form a very characteristic tuft of small lobes at the apex owing to the rapid and repeated dichotomy.

62. **Pellia epiphylla** (L.) Lindb.

Pellia epiphylla Lindb., Hep. in Hib. p. 534 (1874).

Differs from the above in the following characters (after Stephani):—

1. Monoecious.
2. Involucre incomplete in front, merely a flap on the posterior side of the cavity containing the calyptra.
3. Calyptra much exserted. Capsule globose, wall 2-3 layers of cells thick. Outer cells with nodular

thickenings, inner cells with semi-annular bands. Free elaters mostly bispiral, fixed elaters trispiral.

Macvicar describes also the interlacing thick bands on the walls of the cells of the midrib as a character of this species.

Hab. Near flowing water.

Distrib. Pangi, near *Shaichu*; beyond *Narkanda*.

Note.—The plants are monoecious but the material is otherwise unsatisfactory.

63. **Pellia Neesiana** (G.) Limpr.

Pellia Neesiana (G.) Limpr. in Cohn. Kryp. Fl. 1876, I, p. 329.

Differs from *P. calycina* in the following characters (after Stephani):—

1. Less robust, narrow, often yellowish brown.
2. Involucre forming a short complete cylinder, occasionally split on the dorsal side, mouth truncate, subdenticulate.

Macvicar describes also the interlacing thickened bands present on the cells of the midrib as a character of this species.

Note.—The involucre in *P. calycina* as given under that species has a subdenticulate mouth, thus resembling the involucre of *P. Neesiana* as given above. My specimens referred to *P. calycina* show no trace of the interlacing bands on the cells of the midrib. It is desirable that a large number of specimens of *Pellias* from various localities in the Himalayas be examined in order to settle the question how far the various forms are different from each other.

* * * * *

XXX. CALYCULARIA Mitt.

Calycularia Mitt., Trans. Linn. Soc. Vol. V, p. 122 (1860).

Dioecious. Plants large or medium, gregarious, prostrate, light or deep-green. Thallus dichotomous or innovating from the apex, rarely so from the ventral surface; wings ascending, canaliculate; midrib rather broad, gradually passing into the wings. Wings gradually attenuated from a thick base and one cell thick towards the margins. Amphigastria always present, aggregated towards the apex of the lobes, lanceolate or subulate. Androecia on the dorsal side of the midrib, bracts more or less aggregated, each with one antheridium, erect, hoodlike, apex lacerated. Archegonia aggregated towards the apex on the dorsal side. Bracts long, lanceolate, strongly laciniate, or distantly spinous, united at the base into a ring. Perianth large, broad at the base, infundibuliform, campanulate or inflated-cylindrical, more or less folded, often with longitudinal folds; opening broad, spinous or lacerated. Calyptra large, base more or less thick. Capsule on a short pedicel, broadly oval, wall many-layered, cells of the external layer small, brown and equally thickened. cells of the inner layers delicate. Dehiscence by 4-7 valves. Spores small, papillate or echinate. Elaters short, fusiform, bispiral.

Key to the species.

Plants long, in tufts	*C. crispula.*
Plants short, compact and solitary	*C. compacta.*

64. **Calycularia crispula** Mitt.

Calycularia crispula Mitt., Trans. Linn. Soc. Vol. V, p. 122 (1860).

Dioecious. Plants large, strong, growing in tufts with mosses, pale green, simple or branched, ventral shoots present, up to 20 mm. long and 4 mm. broad, lobes broadly ligulate, margins crisped. Midrib conspicuous from above, 15 cells thick in the middle, broad, projecting ventrally and gradually passing into the wings, wings about half the width of the frond. Amphigastria linear or linear-lanceolate, ending in a few-celled filament, with one- or more-celled filamentous projections ending in rounded mucilaginous cells arising from the margin. Archegonia in a cluster on the dorsal side. Rest not seen.

Hab.	Mixed with mosses.
Distrib.	Garhwal, *Gaurikund*; Kumaon, *Gangolihat*; Dalhousie-Khajiar road, about 7,000 feet.

65. **Calycularia compacta** Kashyap N. S.

Dioecious. Plants small, dark-green, occurring singly among moss and grass, slightly branched, with ventral shoots, 12 mm long and up to 6 mm. broad. Rhizoids from the ventral surface of the midrib, numerous, simple, yellowish. Midrib conspicuous as seen from above, projecting below, up to 16 cells thick; wing thin, crisped, occasionally crenate, one cell thick throughout its greater portion. Amphigastria long linear, bent towards the dorsal side at the apex or merely filamentous, of a few cells each (6-10 cells). Bracts on the male plants many, laciniate, with long, linear or filamentous processes. Antheridia aggregated along the midrib throughout the length of the plant, globular, shortly stalked, accompanied by bracts. Bracts on female plants more or less ovate, laciniate or occasionally simply acuminate. Involucre erect, 1 to 2 mm. long, thick at the base, narrow below, broad above, thin, plicate, mouth shortly lobed, lobes irregularly spinous, denticulate. Rest not seen.

Hab. On moist earth among moss and grass, mixed with *Aneura indica.*

Distrib. Lahul, *Kyelang*, 11,000 feet.

Note.—A small, delicate and very compact plant with very closely crisped margins. Older parts of the midrib mycorrhizal.

Possibly a compact form of *C. crispula* adapted to the dry climate of Lahul. In the present species the plants occur singly and not in tufts as in *C. crispula.* The plant grows up from a cylindrical basal portion, then horizontally, and at the end of the season bends down again.

FAMILY V. ANEURACEAE.

Thallus fleshy or membranous, in *Metzgeria* with a sharply defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, composed usually of two layers of cells, of which the inner possesses more or less distinct semi-annular bands. Elaters either free and tapering towards each end with one broad spiral band, or fixed, short and obtuse with an indistinct spiral band and persistent as erect tufts at the apex of the valves.

XXXI. ANEURA Dum.

Riccardia S. F. Gray, Nat. Arr. Brit. Pl. 1 p. 683 (1821). *Aneura* Dum., Comm. Bot. p. 115 (1822).

Thallus fleshy, often pinnately branched, with usually a broad midrib. Epidermal cells usually smaller than the inner cells. Sex organs on short lateral branches. Male branches with a more or less circular outline, distinct, margin more or less papillate; antheridia usually biseriate. Female branches very short, margin laciniate, enclosing 2-8 biseriate archegonia. Perianth absent. Calyptra large, cylindrical or clavate, fleshy, always with papillae at the apex. Capsule longly pedicellate, oblong-cylindric, opening by four valves to the base, wall of 2 layers of cells, cells with semi-annular bands. Spores small. Elaters short, attenuate, mono-spiral. Fixed elaters persistent as erect tufts on the apex of valve.

Note.—The capsule has a columella-like structure projecting from the apex into the cavity of the capsule and bearing a number of fixed-elaters. On dehiscence this structure also divides into 4 pieces along with the 4 valves and the fixed-elaters remain attached to them sticking outwards.

Gemmae are not uncommon in some species. They are usually 2-celled and are formed endogenously in the cells of the uppermost layer of the thallus, becoming free by the rupture of the cell wall.

Key to the Species.

Thallus lobes broad, usually fleshy,
plants occurring singly or in patches .... *A. indica.*
Thallus lobes long and very narrow,
Plants densely overlapping .... *A. Levieri.*

66. **Aneura indica** St. (Ms.).

Aneura indica St. (Ms.); Kashyap, Jour. Bomb. Nat. Hist. Soc. Vol. XXV, p. 280 (1917).

Dioecious. Thallus simple or irregularly pinnately branched or forming rosettes, loosely attached to the humus or closely attached to the soil. Lobes up to 3 cm. long and 5 mm. broad, thick or thin, margin undulate, slightly raised or firmly fixed to the soil. No distinct midrib, thallus gradually thinning towards the margins; greatest thickness in the middle 8-13 cells. Cells of dorsal epidermis flat, convex, or strongly papilliform. Male plants smaller, irregularly branched, branches rather long and narrow, thick, fleshy, margin turned upwards. Antheridia on small branches with a circular outline, restricted to the central part of the dorsal surface. Archegonia with filamentous or small flat green scales. Sporogonium (from the South Indian Specimens): seta 6 mm. long; capsule shortly cylindrical, 2·5 mm. long. Both layers of the capsule wall with thick brown annular bands. Spores lamellate, with a broad margin, 20-30 μ. Elaters monospiral, 190 μ long.

Hab. Moist rocks, among grass and moss in the hills, or on moist earth in the plains.

Distrib. Common. W. Himalayas, *Dalhousie* (7,000 feet), *Sahasar Dhara* (3,000 feet), *Mussoorie* (6,000 to 7,000 feet), etc; Lahul, *Kyelang* (10,000 feet). Occasionally occurs in the Punjab plains also, *Lahore*, *Sialkot*. South India (Rangachariar).

Note.—This plant is extremely variable. In moist shady places in the hills the plants remain thin and light green, only loosely attached to the soil; while in exposed places (in the plains) the plants are thick, fleshy, deep green, and firmly fixed to the soil. Dorsal epidermal cells of plants from moist places are flat, and of those from exposed places are convex to

Plate XXIII.

ANEURA INDICA. 1—6.

1. A sterile plant.

2. A male plant.

3. A female plant.

4. T.S. of thallus form Simla specimens.

4a. Portion of above magnified to show epidermis.

5. T.S. of thallus from Chamba valley specimens.

5a. Portion of above magnified to show epidermis.

6. T.S. of thallus from Sialkot specimens.

6a. Portion from a similar section to show epidermis.

ANEURA LEVIERI. 7.

7. A plant.

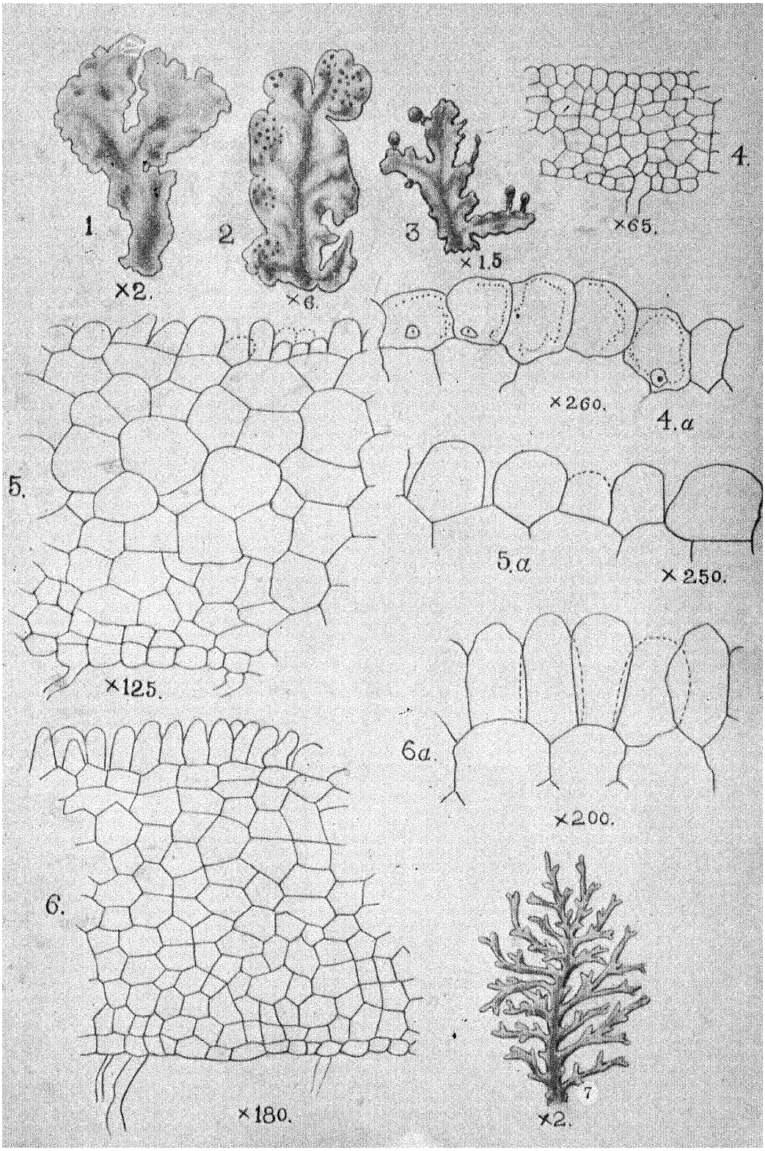

PLATE XXIII.

distinctly papillate. The dorsal epidermal cells of the male plants are always papillate. As a consequence the length of the upper epidermal cells is very variable.

67. **Aneura Levieri** Schff. (Ms.).

Aneura Levieri Schff. (Ms.), St., Sp. Hep. Vol. I, p. 261 (1899).

Plants brownish, densely overlapping in thick patches, very much branched in an irregularly pinnate manner, up to 10 mm. long. Lobes linear or linear-oblong, ultimate branches quadrate or obovate-oblong, or linear in very moist places. No distinct midrib. Main shoot up to 8 cells thick, biconvex in cross-section; cells all alike or epidermal cells rather small. Rest not seen.

Hab. Moist rocks.

Distrib. Chamba-Chauri Road, 6,000 feet; Pangi, in running water, near *Shaichu*, 8000 feet.

Note.—The Pangi specimens are much longer, up to 40 mm., but the older parts are dead. They are also thinner and the ultimate lobes are oblong or linear-oblong.

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XXXII. **METZGERIA** Raddi.

Metzgeria Raddi in Att. Soc. Scient. Mod. 18 p. 34 (1918).

Thallus membranous, usually dichotomously or sometimes pinnately branched, with ventral innovations arising from the sides of the midrib. Midrib slender, sharply defined from the wings, wing of one layer of cells. Sex organs on greatly reduced ventral branches. Antheridia few, shortly pedicellate, globose. Female branch curved into an obcordate involucre furnished with hairs. Perianth absent. Calyptra thick, fleshy, clavate, hairy. Capsule shortly pedicellate, oblong-oval, 4-valved, wall of 2 layers of cells, the outer with nodular thickenings, the inner with indistinct annular bands. Spores small, spherical, smooth or minutely papillate. Elaters long, attenuate, monospiral, the spiral band broad, reddish brown. Fixed elaters partly persistent as erect tufts on the apex of the valves. Gemmae discoid to linear.

Note.—The genus is at once recognised by the distinct midrib and 1-layered wing.

Key to the species.

Plants with straight bristles all over the surface and the margins...*M. pubescens.*
Plants with long slender hairs only on the under surface of the midrib and along the margins..............................*M. himalayensis.*

68. **Metzgeria pubescens** Raddi.

Metzgeria pubescens Raddi in Att. Soc. Scient. Mod. 18 p. 46 (1918).

Dioecious. Plants forming rather large patches on rocks, or thin layers on mosses, etc., yellowish green. Thallus up to 50 mm. long and 2 mm. broad, irregularly pinnate or more or less distinctly dichotomous, margin undulate, wing sometimes interrupted; thickly beset on both surfaces and margins with straight bristles. Ventral innovations very common. Midrib subterete, highly and almost equally arched on both surfaces. Cells of the wing 5-6-angled, not elongate, 32-40 μ. in diam., walls thin, angles hardly thickened. Male branch with hairs only on the postical surface. Female branch with hairs on both surfaces.

Hab. Moist shady rocks.

Distrib. Common 7,000—10,000 feet. Dalhousie-Chamba road; Chamba-Pangi road; Kulu, *Bhaboo pass*; Kumaon, *Mussoorie*, near *Gangotri*, etc.

Note.—The plant can be very easily recognised by the densely arranged bristles on both surfaces of the thallus (midrib as well as the wings) and along the margins. The plant varies greatly in size and mode of branching. Some plants are long and robust extending up to 50 mm. in length, and up to 2 mm. in breadth of lobes, and are always pinnate. Others are much smaller, delicate, not exceeding 1 mm. in breadth and they are more or less distinctly dichotomous. Intermediate forms are also met with.

PLATE XXIV.

METZGERIA PUBESCENS. 1—2.

1. Four plants showing habit.
2. Two T.S. of thallus.

METZGERIA HIMALAYENSIS. 3—5.

3. A plant. 4. T.S. of thallus. 5. Part of the wing in surface view, with marginal hairs.

BLASIA PUSILLA. 6—10.

6. A plant. 7. A plant bearing a flask-shaped gemmae-receptacle. 8. An amphigastrium.
9. Two stellate gemmae. 10. Gemma from the flask-shaped receptacle.

PELLIA CALYCINA. 11—12.

11. A male plant.
12. A female plant.

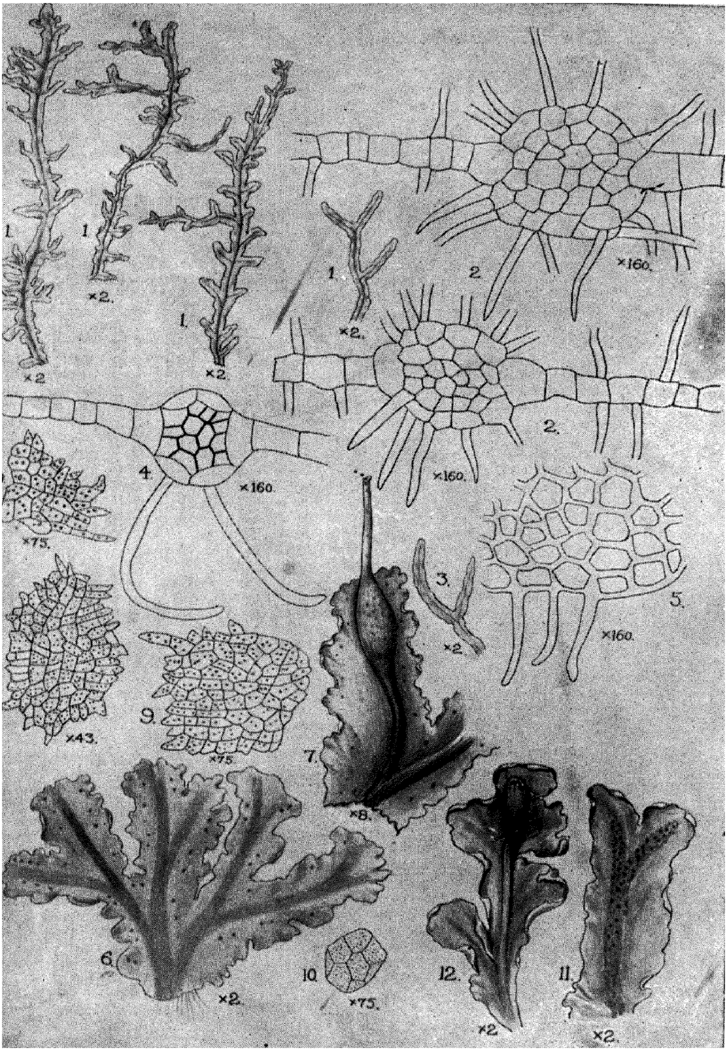

PLATE XXIV.

69. **Metzgeria himalayensis** Kashyap.

Metzgeria himalayensis Kashyap, Jour. Bom Nat. Hist. Soc., Vol. XXVI., p. 280 (1917).
Metzgeria curviseta St., Sp. Hep. Vol. VI. p. 49 (1917).

Monoecious. Plants deep green, dichotomous, up to 15 mm. or more long. Lobes up to 4 mm. long and up to 1 mm. broad. Midrib biconvex, lamina plane or undulate, occasionally interrupted. Long hairs present on the undersurface of the midrib and along the margins, the rest naked. Midrib 4 to 6 cells thick and 3-4 cells broad through the centre. Epidermal cells of the midrib 2/2. Lamina in older parts up to 14 cells on each side ; cells 32 µ × 30 µ. Male branches without hairs. Female branches with numerous hairs.

Hab. Moist places.

Distrib. Fairly common from 5,000—9,000 feet. *Dalhousie*; Kulu, *Bhaboo pass*; *Mussoorie*; etc.

Note.—The number of hairs on the thallus in this species varies very greatly. Sometimes there is a regular fringe all along the margin and many hairs may be met with on the ventral side of the midrib. In other cases only a few hairs are met with, here and there, on the margin, and none may occur on the midrib. The hairs may be straight, long and slender, or hamate.

ORDER IV.

SPHAEROCARPALES.

Gametophyte a thallus, without air-chambers and pores. Rhizoids smooth. Each antheridium and archegonium enclosed in a special envelope. Sporogonium with a large foot and a short seta. Capsule wall one-layered without fibrous bands on the cells. Sterile cells thin-walled and disappearing at maturity. Dehiscence irregular.

FAMILY VI. RIELLACEAE

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters the same as those of the Order.

XXXIII. RIELLA Mont.

Riella Mont.. Ann. Sc. Nat. 3, XVIII, p. 11. (1852).

Plants thallose, small or medium, delicate, light green, erect or ascending, with thin-walled rhizoids at the base, under water, occasionally on moist soil when water has flown away. Midrib in section elliptical, central cells elongated, cortical cells parenchymatous. Branching furcate. Wing arising from the dorsal side of the midrib, 1-layered, delicate, narrow at the base, well developed above, falcate-rotund at the apex; margin entire, or slightly lobed or incised, plane or slightly undulate. Leaves on the dorsal side, on the right or left of the wing, rudimentary or well developed. Antheridia on the margin of the wing, immersed, in rows, shortly pedicellate, ovoid, each surrounded by an envelope, papillae inconspicuous. Archegonia from the dorsal side of the midrib, each surrounded by an involucre, involucre large, 1-layered, ovoid, in the upper portion

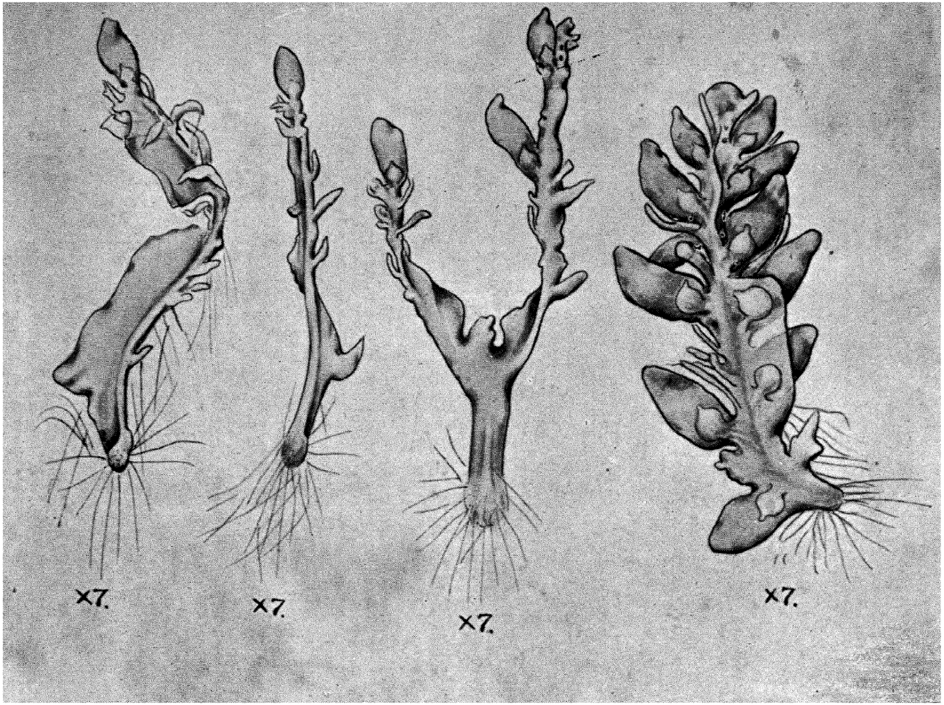

PLATE XXV.

PLATE XXV.

RIELLA INDICA.

Four plants showing habit.

more or less inflated, opening small. Calyptra strong, 2-layered. Capsule spherical, wall 1-layered, pedicel short, foot thick. Spores large, tetrahedral, minutely reticulate-lamellate. Sterile cells a little smaller than the spores, hyaline, without any spiral bands.

Note.—The dorsal wing distinguishes this genus from all other liverworts, and the plants of this genus are always aquatic. The sterile cells are disorganised when the spores are ripe.

70. **Riella indica** St. (Ms.)

Riella indica St. (Ms.), Kashyap, Jour. Bom. Nat. Hist. Soc. Vol. XXV, p. 279 (1917).

Plants submerged, erect or ascending, firmly fixed to the mud by the rhizoids, often in dense patches, light green, simple or once or twice forked, up to 10 mm. long. Often many branches are given off from the base and plants have a tufted habit. Wing well developed in early stages, up to 2 mm. broad, in the fertile portion small and interrupted. Lateral leaves (bracts) long and narrow, linear, conspicuous. Involucres up to 6 on each plant, densely situated, cylindrical, pointed, up to 2 mm. long, cells papilli-form. Spores reticulate on the convex side, 7-8 reticulations in the diameter, the angles projecting as spines, merely spinous on the flat sides, 60-70 µ.

Hab. In shallow water in a water channel of the Shalamar Garden, *Lahore*; occasionally on mud.

Note.—The plants were first found in the months of February and March of 1913 and 1914. This is the only species of the genus so far found in India.

SYNOPSIS.

(*Species restricted to India only are marked with an asterisk**)

Phylum :—BRYOPHYTA.
Class :—HEPATICAE.
Order I, ANTHOCEROTALES.
Family I, ANTHOCEROTACEAE.
Genus I. ANTHOCEROS
Species 1, A. erectus *
2, A. himalayensis *
3, A chambensis *
4, A. Gollani *
5. A. Longii *
Genus II, NOTOTHYLAS
6, N. indica *
7, N. Levieri*
Order II, MARCHANTIALES
Family II, MARCHANTIACEAE
Genus III, MARCHANTIA
8, M. polymorpha
9, M. palmata
10, M. nepalensis*
11, M. simlana*
Genus IV, PREISSIA
12, P. quadrata
Genus V, WIESNERELLA
13, W. denudata
Genus VI, DUMORTIERA
14, D. hirsuta
Genus VII. CONOCEPHALUM
15, C. conicum
Genus VIII, LUNULARIA
16, L. cruciata
Genus IX, EXORMOTHECA

17, E. tuberifera *
Genus X, STEPHENSONIELLA
18, S. brevipedunculata *
Genus XI, AITCHISONIELLA
19, A. himalayensis *
Genus XII, CYATHODIUM
20, C. tuberosum*
Genus XIII, TARGIONIA
21, T. hypophylla
Genus XIV, CRYPTOMITRIUM
22, C. himalayense *
Genus XV, MASSALONGOA
23, M. tenera *
Genus XVI, FIMBRIARIA
24, F. Blumeana
25, F. angusta*
26, F. pathankotensis *
27, F. mussuriensis *
28, F. reticulata*
29, F. maculata*
30, F. nepalensis*
31, F. parvipora*
32, F. sanguinea*
33, F. multiflora*
34, F. Gollani*
35, F. papulosa*
Genus XVII, GRIMALDIA
36, G. indica *
Genus XVIII, REBOULIA
37, R. hemispherica
Genus XIX, PLAGIOCHASMA
38, P. articulatum *
39, P. appendiculatum
40, P. simlensis *
41, P. intermedium
42, P. cordatum*
43, P. quadricornutum*

Genus XX, SAUCHIA
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Genus XXI, SAUTERIA
45, S. alpina
Genus XXII, ATHALAMIA
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47, A. dioica*
48, A. pusilla*
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Genus XXIV, RICCIA
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51, R. himalayensis *
52. R. melanospora *
53. R. robusta *
54, R. cruciata*
55, R. sanguinea*
56. R. fluitans

Order III, JUNGERMANNIALES

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Genus XXV, FOSSOMBRONIA
57, F. himalayensis *
Genus XXVI, SEWARDIELLA
58, S. tuberifera *
Genus XXVII, PETALOPHYLLUM
59. P. indicum *
Genus XXVIII, BLASIA
60. B. pusilla
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62, P. epiphylla
63, P. Neesiana
Genus XXX, CALYCULARIA
64, C. crispula*
65, C. compacta*

- Family V, ANEURACEAE
  - Genus XXXI, ANEURA
    - 66, A. indica *
    - 67, A. Levieri *
  - Genus XXXII, METZGERIA
    - 68, M. pubescens
    - 69, M. himalayensis *

Order IV, SPHAEROCARPALES

- Family VI, RIELLACEAE
  - Genus XXXIII, RIELLA
    - 70, R. indica *

Total number of Genera		33
Genera restricted to India		6
Total number of species		70
Species restricted to India		50
Species restricted to the Himalayas including the foot of the hills, rarely in the plains	34	50
Species met with in the hills as well as the plains. Nos. 1, 17, 20, 38, 51, 53, 57, 68	8	
Species restricted to the plains up to the foot of the hills. Nos. 6, 26, 50, 52, 54, 55, 59, 70	8	

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APPENDIX I.

Climatic Details of some Important Places.

LAHORE.

Height above sea level ... ... 700′.
Average annual rainfall ... ... 19·58″.

In summer the temperature goes up to 115° F. or sometimes even more. In winter during the nights the temperature on the grass falls below 32° F. and for a couple of months there is hoar frost of 5° to 10°. The rain falls mostly in July and August, but a small amount falls in winter also. The summer is very hot and dry being quite hostile to the growth of tiny and delicate plants like Liverworts.

SIMLA.

Height above sea level ... ... 6,000′ to 8,000′.
Average annual rainfall ... ... 63″.

The mean maximum temperature in winter (December to February) ranges between 49°.4 F. and 44° .5 F. and the mean minimum temperature between 39°.1 F. and 34°.5 F. The mean maximum temperature in summer (in June, the hottest month) is 74°.4 F. and the mean minimum is 61°. 0 F.

Snow falls in winter which is the resting season. The rain chiefly falls from July to September.

MUSSOORIE.

Height above sea level ... ... 6,000 to 8,000′.
Average annual rainfall ... ... 109·69″.

The climate is very much like that of Simla. As the station has got a moist and humid climate the Hepatic flora is very rich.

DALHOUSIE.

Height above sea level ... ... 6,000 to 8000′.
Average annual rainfall ... ... 83·88″,

Being further north west to the above mentioned stations the climate is not as suitable as that of the two stations, given above, therefore, the vegetation is a little less luxuriant.

KULU.

Height above sea level	(Nagar)	5,780′.
Height above sea level	(Sultanpur)	4,000′.
Average annual rainfall	(Nagar)	49·4″.
Average annual rainfall	(Sultanpur)	39·74″,

Snow falls in winter at Nagar and the winter is severe in the higher lying tracts of Kulu, and in sheltered places snow lies well till April. The mean temperature from June to August at Sultanpur is about 75° F. Mean minimum from January to February 41° F. (Kulu Gazetteer).

CHAMBA.

Height above sea level	3,027′.
Average annual rainfall	47·6″.
Mean maximum temperature	77°.7 F.
Mean minimum temperature	56°.5 F.

In the Ravi Valley the climatic conditions vary with the altitude. In the lower portion of the Valley, from the capital downwards they are of a semi-tropical character. The heat is great and rainy season well marked, while the winter is mild and the snowfall light. In the capital the maximum temperature recorded is 108°.3 F. and the minimum 30°.3 F. From the capital upwards the conditions are more severe, and vary from temperate to semi-arctic. Arctic conditions prevail along the high ranges for several months in winter. In the Brahmaur Wizarat the summer is mild, but winter is severe. (Chanba Gazetteer).

KYELANG.

Height above sea level	10,000′
Average annual rainfall including winter (melted) snow	23″
Average annual rainfall not including winter snowfall	6″

The climate of Lahul is most bracing. The air is crisp and keen especially in the Valley of the Chandra; that of the Bhaga Valley at Kyelang has not quite the same vigorous quality. The maximum temperatures at Kyelang range from 33°.3 F. in February to 73°.6 F. in August, the minimum from 13°.4 F. in February to 50°.2 F. in July. Lahul is set in a basin, the edge of which consists of enormous mountain ranges. These barriers keep off the monsoon currents, causing the rain to spend itself on their south and west faces. In consequence the summer rainfall in Lahul is scanty, affecting on the average no more than three days in each month. The total rainfall during the whole season from June to September is about 6″. On the other hand nearly three times as much precipitation occurs during the period of December to May, and is then associated mainly with storms of high elevation which traverse Northern India from west to east and pass over the mountains which obstruct the monsoon in summer. (Kulu Gazetteer).

In the Chandra Bhaga Valley the climate is temperate in summer and semi-arctic in winter. As the lowest altitude in the Pangi Valley is 7,000 feet, no great heat is felt. The summer is exceedingly mild and pleasant, while owing to the scanty rainfall the degree of humidity is always low. The winter, however, is very severe. Snow commences to fall in October but does not lie permanently till December, after which the whole valley is under snow till March or April. (Chamba Gazetteer).

LEH (LADAK).

Height above sea level	11,000′.
Average annual rainfall	3″.

Winter is very severe. Cold and dry winds are prevalent in the whole of Ladak. Trees are met with only in low lying sheltered places. In Rupshu the altitude of the plateau is from 13,000 feet to 16,000 feet at different places, and the climate is extremely rigorous there are absolutely no trees there.

APPENDIX II.

LIVERWORTS OF CERTAIN LOCALITIES.

(*Species of the Acrogynous Jungermanniales are not included*).

1. Panjab plain (Lahore, etc.).

1. *Anthoceros himalayensis*. Lahore.
2. *Anthoceros chambensis*, rare, Sialkot.
3. *Marchantia palmata*, common, everywhere.
4. *Marchantia nepalensis*, common, everywhere.
5. *Cyathodium tuberosum*, rare, Jullundur.
6. *Fimbriaria pathankotensis*, fairly common, Lahore.
7. *Grimaldia indica*, rare, Amritsar.
8. *Plagiochasma appendiculatum*, common, Lahore.
9. *Plagiochasma articulatum*, rare, Lahore.
10. *Riccia pathankotensis*, rare Lahore.
11. *Riccia himalayensis*, rare, Lahore.
12. *Riccia robusta*, common, Lahore.
13. *Riccia cruciata*, rare, Lahore.
14. *Riccia sanguinea*, very common along rivers everywhere.
15. *Aneura indica*, rare, Sialkot, Lahore.
16. *Fossombronia himalayensis*, rare Lahore.
17. *Petalophyllum indicum*, fairly common on riverside, Lahore.
18. *Riella indica*, rare, Lahore.

The number of species becomes larger and individuals of each species more numerous as we go to the foot of the hills. The two species of *Plagiochasma*, *Grimaldia indica*, *Fimbriaria pathankotensis*, *Riccia pathankotensis* and *Riccia himalayensis* become particularly common. *Ricciocarpus natans* and *Riccia fluitans* are met with at Peshawar.

2. Pangi and Lahul (Chandra-Bhaga Valley) 8,000 to 10,000 ft.

1. *Marchantia polymorpha*, fairly common.
2. *Preissia quadrata*, very common.

3. *Dumortiera hirsuta*, not common.
4. *Fimbriaria reticulata*, above Kyelang.
5. *Grimaldia indica*, above Kyelang.
6. *Reboulia hemispherica*, common.
7. *Athalamia pusilla*, above Kyelang.
8. *Riccia robusta*, above Kyelang,
9. *Aneura indica*, Kyelang.
10. *Pellia calycina*, common.
11. *Pellia epiphylla*, Shaichu.
12. *Calycularia compacta*, Kyelang.

The following have been met with in the Chandra Valley a~~d~~bove 13,000.

Sauchia spongiosa, Dokpo Gongma, about 15,000 feet, and just below the top of the Manh pass.

Riccia robusta, Chandra Dal.

3. Spiti.

Reboulia hemispherica.

Riccia robusta.

Specimens were collected only between the Manh pass (coming from the Chandra Valley) and Losar.

4. Transhimalayan region (Ladak etc.)

1. *Marchantia polymorpha*, beyond the Baralacha pass near Kinlung, about 15,000 feet: Kargil, Leh, etc.
2. *Preissia quadrata*, beyond the Baralachapass near Kinlung, about 15,000 feet.
3. *Sauchia spongiosa*, beyond the Baralacha pass near Kinlung, a little below 15,000 feet.
4. *Plagiochasma articulatum*, Ladak.

Only a foliose acrogynous species has been found in Zanskar, at about 14,000 feet. Only the upper part of the Valley above Tangse has, however, been visited. More species may be expected in the lower parts.

5. Kashmir Valley.

The list is very incomplete, specially as there is a great range of altitudes.

1. *Marchantia palmata.*
2. *Marchantia nepalensis.*
3. *Preissia quadrata.*
4. *Reboulia hemispherica.*
5. *Plagiochasma appendiculatum.*
6. *Fimbriaria reticulata.*
7. *Ricciocarpus natans.*
8. *Pellia calycina.*

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